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VOL. III.

PALEY'S NATURAL THEOLOGY,

WITH ADDITIONS FROM

LORD BROUGHAM, AND SIR CHARLES BELL,

A LIFE AND PORTRAIT OF THE AUTHOR, AND NUMEROUS OTHER ILLUSTRATIONS.

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NATURAL THEOLOGY.

CHAPTER XVII.

THE RELATION OF ANIMATED BODIES TO INANIMATE NATURE.

WE have already considered *relation*, and under different views; but it was the relation of parts to parts, of the parts of an animal to other parts of the same animal, or of another individual of the same species.

But the bodies of animals hold, in their constitution and properties, a close and important relation to natures altogether external to their own: to inanimate substances, and to the specific qualities of these; e. g. *they hold a strict relation to the* ELEMENTS *by which they are surrounded.*

I. Can it be doubted, whether the *wings of birds* bear a relation to air, and the *fins of fish* to water? They are instruments of motion severally suited to the properties of the medium in which the motion is to be performed; which properties are different. Was not this difference contemplated when the instruments were differently constituted?

II. The structure of the animal *ear*, depends for its use not simply upon being surrounded by a fluid, but upon the specific nature of that fluid. Every fluid would not serve: its particles must repel one another; it must form an elastic medium: for it is by the successive pulses of *such* a medium, that the undulations excited by the surrounding body are carried to the organ; that a communication is formed between the object and the sense; which must be done, before the internal machinery of the ear, *subtile as it is,* can act at all.

III. The *organs* of voice and respiration are, no less than the ear, indebted, for the success of their operation, to the peculiar qualities of the fluid in which the animal is immersed. They, therefore, as well as the ear, are constituted upon the supposition of such a fluid, *i. e.*, of a fluid with such particular properties, being always present. Change the properties of the fluid, and the organ cannot act; change the organ, and the properties of the fluid would be lost. The structure, therefore, of our organs, and the properties of our atmosphere, are made for one another. Nor does it alter the relation, whether you allege the organ to be made for the element, (which seems the most natural way of considering it,) or the element as prepared for the organ.

IV. But there is another fluid with which we have to do; with properties of its own; with laws of acting, and of being acted upon, totally different from those of air and water: and that is *light*. To this new, this singular element—to qualities perfectly peculiar, perfectly distinct and remote from the qualities of any other substance with which we are acquainted—an organ is adapted, an instrument is correctly adjusted, not less peculiar amongst the parts of the body, not less singular in its form and in the substance of which it is composed, not less remote from the materials, the model, and the analogy of any other part of the animal frame, than the element to which it relates is specific amidst the substances with which we converse. If this does not prove appropriation, I desire to know what would prove it.

Yet the element of light, and the organ of vision, however related in their office and use, have no connexion whatever in their original. The action of rays of light upon the surfaces of animals has no tendency to breed eyes in their heads. The sun might shine for ever upon living bodies, without the smallest approach towards producing the sense of sight. On the other hand also, the animal eye does *not* generate or emit light.

V. Throughout the universe there is a wonderful *proportioning* of one thing to another. The size of animals, the human animal, especially, when considered with respect to other animals, or to the plants which grow around him, is such as a regard to his conveniency would have pointed out. A giant or a pigmy could not have milked goats, reaped corn, or mowed grass; we may add, could not have rode a horse, trained a vine, shorn a sheep, with the same bodily ease as we do, if at all. A pigmy would have been lost amongst rushes, or carried off by birds of prey.

It may be mentioned, likewise, that, the model and the materials of the human body being what they are, a much greater bulk would have broken down by its own weight. The persons of men who much exceed the ordinary stature betray this tendency.

VI. Again, (and which includes a vast variety of particulars, and those of the greatest importance,) how close is the *suitableness* of the earth and sea to their several inhabitants; and of these inhabitants to the places of their appointed residence!

Take the *earth* as it is; and consider the correspondency of the powers of its inhabitants with the properties and condition of the soil which they tread. Take the inhabitants as they are; and consider the substances which the earth yields for their use. They can scratch its surface, and its surface supplies all which they want. This is the length of their faculties; and such is the constitution of the globe, and their own, that this is sufficient for all their occasions.

When we pass from the earth to the *sea*, from land to water, we pass through a great change; but an adequate change accompanies us of animal forms and functions, of animal capacities and wants; so that *correspondency* remains; the earth in its nature is very different from the sea, and the sea from the earth, but one accords with its inhabitants as exactly as the other.

VII. The last relation of this kind which I shall mention, is that of *sleep* to *night*; and it appears to me to be a relation which was expressly intended. Two points are manifest, first, that the animal frame requires sleep; secondly, that night brings with it a silence and a cessation of activity which allows of sleep being taken without interruption and without loss. Animal existence is made up of action and slumber ; Nature has provided a season for each. An animal which stood not in need of rest would always live in daylight. An animal which, though made for action, and delighting in action, must have its strength repaired by sleep, meets, by its constitution, the returns of day and night. In the human species, for instance, were the bustle, the labor, the motion of life upheld by the constant presence of light, sleep could not be enjoyed without being disturbed by noise and without expense of that time which the eagerness of private interest would not contentedly resign. It is happy, therefore, for this part of the creation I mean, that it is conformable to the frame and wants of their constitution, that Nature, by the very disposition of her elements, has commanded, as it were, and imposed upon them, at moderate intervals, a general intermission of their toils, their occupations, and pursuits.

But it is not for man, either solely or principally, that night is made. Inferior but less perverted natures taste its solace, and expect its return, with greater exactness and advantage than he does. I have often observed, and never observed but to admire, the satisfaction, no less than the regularity, with which the greatest part of the irrational world yield to this soft necessity, this grateful vicissitude ; how comfortably the birds of the air, for example, address themselves to the repose of the evening, with what alertness they resume the activity of the day.

Nor does it disturb our argument to confess, that certain species of animals are in motion during the night, and at rest in the day. With respect even to them, it is still true, that there is a change of condition in the animal, and an external change corresponding with it. There is still the relation, though inverted. The fact is, that the repose of other animals sets these at liberty, and invites them to their food or their sport.

If the relation of *sleep* to *night*, and, in some instances, its converse, be real, we cannot reflect without amazement upon the extent to which it carries us. Day and night are things close to us ; the change applies immediately to our sensations; of all the phenomena of Nature, it is the most obvious and the most familiar to our experience; but, in its cause, it belongs to the great motions which are passing in the heavens. Whilst the earth glides round her axle, she ministers to the alternate necessities of the animals dwelling upon her surface, at the same time that she obeys the influence of those attractions which regulate the order of many thousand worlds. The relation, therefore, of sleep to night is the relation of the inhabitants of the earth to the rotation of their globe; probably it is more, it is a relation to the system of which that globe is a part; and, still further, to the congregation of systems of which theirs is only one. If this account be true, it connects the meanest individual with the universe itself,—a chicken roosting upon its perch with the spheres revolving in the firmament.[53]

---

[53] Nothing is more true, than that the strength of the bones and the power of the muscles stand in intimate relation with the weight of the body, that is also, in relation with the attraction of the globe itself. It is no less certain, that many of the living properties of animals, the condition of the nervous system, and the alternation of exertion and repose in the muscular system, are related to the change of day and night, or to the revolving of our planet upon its axis. In man, we may see a slight deviation in his habits and occupations from this correspondence with the succession of light and darkness; yet he enjoys a return of energy and elasticity of spirits, which is followed by weariness and exhaustion; and health will not long continue without yielding to the alternate condition of activity and repose. In nothing do we see the benevolence of the Creator more, than in the continued gratification consequent on this arrangement alone, and more especially in the brutes. It is not a mere effect of light, and the freshness of the morning, which produces the almost universal animation and activity of that time of day; for to many animals the light of day is the signal to seek repose; and that it is not the mere necessity which brings animals abroad at night, in order to feed secluded, or escape their enemies, we know from this, that their organs are adapted to the obscurer light, and not their organs only but their propensities; for they are as full of activity and enjoyment as the things of day. The history of pulmonary and other complaints, indicates a curious connexion between the functions of the body and the revolution of time, or alternations of day and night.

But the most remarkable accommodation of the economy of animals, and the property of life itself in them, regards the changes of the year rather than the diurnal change. How much this prevails in the vegetable world, we have only to look around us fully to comprehend. With the diminution of heat, vegetation is nipped, the ova of insects locked

VIII. But if any one object to our representation, that the succession of day and night, or the rotation of the earth upon which it depends, is not resolvable into central attraction, we will refer him to that which certainly is,—to the change of the seasons. Now the constitution of animals susceptible of torpor bears a relation to winter similar to that which sleep bears to night. Against not only the cold, but the want of food, which the approach of winter induces, the Preserver of the world has provided in many animals by migration, in many others by torpor. As one example out of a thousand, the bat, if it did not sleep through the winter, must have starved; as the moths and flying insects upon which it feeds disappear. But the transition from summer to winter carries us into the very midst of physical astronomy, that is to say, into the midst of those laws which govern the solar system at least, and probably all the heavenly bodies.

up, and the food of many animals withdrawn. Some animals could not be protected by an instinct of migration, being without the means of passage: the bat could not fly away with the swallow, nor the hedgehog and dormouse travel with the deer. To sustain the animal heat against the low temperature of the surrounding atmosphere, requires a vigorous circulation of the blood, and a plentiful and uninterrupted supply of food. Many animals must, therefore, have died during the winter, had not Nature supplied a means of their continuance in life beyond the ingenuity of man to conceive. The warmth of their clothing, and the instincts to build themselves a warm habitation, which we should almost say were the exercise of ingenuity, are insufficient. To sustain life they must hold it by a new tenure. Accordingly, the necessity for food is removed; the activity of the circulation is diminished remarkably; a torpor seizes upon every living faculty, and they fall into what seems a long sleep. Yet it is not sleep, but a new condition of existence, in which life is preserved without the necessity for food, and when all the functions of the system are let down to a lower state of activity. And justly, therefore, it has been said, that in these things we trace the benevolence of the Creator, "who did not cast his living creatures into the world to prosper or perish as they might find it suited them or not, but fitted together with the nicest skill the world and the constitution which He gave to its inhabitants; so fashioning it, that light and darkness, sun and air, moist and dry, should become their ministers and benefactors, the unwearied and unfailing causes of their wellbeing."—*Whewell's Bridgewater Treatise.*—ENG. ED.

[THE RELATION OF THE BODIES OF BIRDS TO THE ATMOSPHERE.

The first object noticed in Chap. xvii. is the wing of a bird, and this is given as an instance, of *the relation of the animal body to the elements by which it is surrounded.*

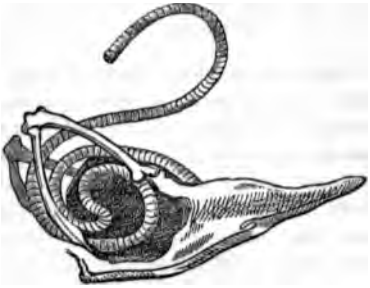
We entreat our readers' attention to the philosophy of this subject. And let us not be contented with admiring the structure of the feather, or the adaptation of the bones of the wing to their office, but let us go deeper into the inquiry: it is a subject which will reward us.

Let us take it for granted, that a creature is to live by the exercise of the same functions with the races of mammalia or quadrupeds, as digestion, assimilation, respiration, &c.; but that it must rise in the air, and seek its food by long flights. What are the circumstances necessary to this new condition? Is it not obvious, that the creature must be specifically lighter or more buoyant, in the atmosphere?—that instead of its muscular system being divided, and directed to the movement of the four extremities, it must have its strength principally directed to the wings, that it may extend them, and be able to raise its body upon them? Let us see, then, how this is accomplished, and how the original animal economy is interwoven with an entirely new machinery of motion.

The first object will be obtained, by enlarging the body of the bird, without increasing the weight in any thing like the same proportion—and one very obvious means will be found, in extending the trachea or windpipe. In examining the tame and wild swan, the most careless observer will detect the provision for flight in the latter, by the conformation of the windpipe, which is curiously convoluted within the sternum or breast-bone.

This sketch from the male crane will illustrate what we mean. The light and hollow air-tube fills a space in the interior of the bone, by which the surfaces are extended for the attachment of the muscles of the wings, and thus two objects are attained through it.

In attempting to explain the reason of such deviations from the common forms of parts, we are liable to fall into



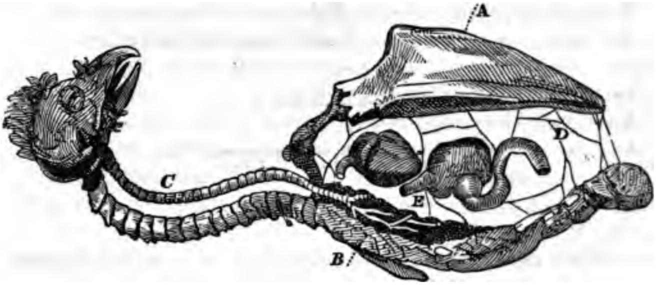
the same mistakes as we find occasionally in commentators on the Sacred Volume. Were we seeking for the varieties of the organs of voice, we might here start to the conclusion, that we had found in the animal body a complex instrument resembling a trombone, or Siberian hunting horn ; but by further inquiry we should discover, that some of those birds that have the most complex and varied windpipe, have no cry at all.

But there is a still more curious provision for the extension, and magnitude, of the body of a bird, independently of weight. In birds, the air does not only pass into their lungs, but through them, so as to fill a series of air-cells, composed of fine membranes, which are interwoven with all the viscera. The heart is surrounded by such a cell. Two great cells are attached to the liver ; and in the same manner are all the viscera of the abdomen interspersed with air-cells, and these all communicate. The air thus admitted into the interior of the body, extends even into the bones. Naturalists have mistaken the end of this structure, when they have represented it as a developement of the respiratory organs. It is not to make the function of respiration more perfect, that the air enters so extensively into the body ; as a proof of which, the air in the bones of the head is supplied through the nasal cavities and Eustachian tubes, independently of the lungs altogether.*

---

* Mr. Hunter's 'Animal Economy.'

Mr. Hunter has shown us, that in many birds the internal air-cells communicate with the exterior cellular membrane, especially in the neck and axilla, which marks an analogy with the air-cells under the skin of the bat. Winged insects, too, have their bodies extended by air-cells, communicating with their respiratory apparatus. These facts sufficiently evince the object of Nature in this extension of the air-cells; that it is not for the purpose of breathing, but for enlarging the volume of the body without increasing the weight.



We must observe the very peculiar mechanism of the bird's respiration. The breastbone or *sternum*, A, runs the whole length of the animal's body; and the great central spine of that bone, called the *keel*, rises from it, so as to give lodgement and attachment to the great muscles of the wings. It will be easily understood, how naturalists distinguish birds of passage by the size of the keel, (crista,) since its greater prominence implies strength of wing for long-continued flight. Under the breastbone, and between it and the backbone, we perceive the space occupied by air-cells. The lungs, B, lie behind; and by the motion of the bone A, like a great bellows, the air is drawn through the lungs, and through the windpipe, C, into the cells D, E; at once effectually oxygenating the blood in the lungs, and renewing the air within the recesses of the body.

The next thing remarkable, is in the vertebræ of birds, for the backbone is in its constitution unlike that of man or quadrupeds. The back is firm, and the caudal extremity loose and movable. The first is obviously intended to give a fixed origin to the muscles of the wing, and the second to afford motion to the tail. It is by the wings they raise or propel themselves, and by the tail they direct their flight. We need hardly add, that there is a change in the centre of gravity compared with that of animals; in birds, the centre is between the wings.

If our reader has followed us in these details, he will acknowledge that there cannot be a more curious instance, of a change and adaptation of the whole system of the living body, to the external elements, than is to be found in the system of birds.—SIR CHARLES BELL.]

CHAPTER XVIII.

INSTINCTS.

THE order may not be very obvious by which I place *instincts* next to relations. But I consider them as a species of relation. They contribute, along with the animal organization, to a joint effect, in which view they are related to that organization. In many cases, they refer from one animal to another animal; and, when this is the case, become strictly relations in a second point of view.

An INSTINCT is a propensity prior to experience, and independent of instruction. We contend, that it is by *instinct* that the sexes of animals seek each other; that animals cherish their offspring; that the young quadruped is directed to the teat of its dam; that birds build their nests, and brood with so much patience upon their eggs; that insects, which do not sit upon their eggs, deposit them in those particular situations, in which the young when hatched find their appropriate food; that it is instinct which carries the salmon, and some other fish, out of the sea into rivers, for the purpose of shedding their spawn in fresh water.

We may select out of *this* catalogue the incubation of eggs. I entertain no doubt, but that a couple of sparrows hatched in an oven, and kept separate from the rest of their species, would proceed as other sparrows do, in every office which related to the production and preservation of their brood. Assuming this fact,[54] the thing is inexplicable upon any other hypothesis than that of an instinct, impressed upon the constitution of the animal. For, first, what should induce the female bird to prepare a nest before she lays her eggs? It is in vain to suppose her to be possessed of the faculty of reasoning; for no reasoning will reach the case. The fulness or distension, which she might feel in a particular part of the body, from the growth and solidity of the egg within her, could not possibly inform her that she was about to produce something which, when produced, was to be preserved and taken care of. Prior to experience there was nothing to lead to this inference, or to this suspicion. The analogy was *all* against it; for, in every other instance, what issued from the body was cast out and rejected.

But, secondly, let us suppose the egg to be produced into day; how should birds know that their eggs contain their young? There is nothing either in the aspect or in the internal composition of an egg, which could lead even the most daring imagination to conjecture, that it was hereafter to turn out from under its shell a living, perfect bird. The form of the egg bears not the rudiments of a resemblance to that of the bird. Inspecting its contents, we find still less reason, if possible, to look for the result which actually takes place. If we should go so far as, from the appearance of order and distinction in the disposition of the liquid substances which we noticed in the egg, to guess, that it might be designed for the abode and nutriment of an animal, (which would be a very bold hypothesis,) we should expect a tadpole dabbling in the slime, much more than a dry, winged, feathered creature; a compound of parts and properties, impossible to be used in a state of confinement in the egg, and bearing no conceivable relation, either in quality or material, to any thing observed in it. From the white of an egg, would any one look for the feather of a goldfinch? or expect from a simple, uniform mucilage, the most complicated of all machines, the most diversified of all collections of substances? Nor would the process of incubation, for some time at least, led us to suspect the event. Who that saw red streaks shooting in the fine membrane which divides the white from the yolk, would suppose that these were about to become bones and limbs? Who that espied two discolored points, first making their appearance in the cicatrix, would have had the courage to predict, that these points were to grow into the heart and head of a bird? It is difficult to strip the mind of its experience. It is difficult to resuscitate surprise, when familiarity has once laid the sentiment asleep. But, could we forget all that we know, and which our sparrows never knew, about oviparous generation—could we divest ourselves of every information but what we derived from reasoning upon the appearances or quality discovered in the objects presented to us—I am convinced, that Harlequin coming out of an egg upon the stage, is not more astonishing to a child, than the hatching of a chicken, both would be, and ought to be, to a philosopher.[55]

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[54] There can be very little doubt of this assumption being according to the fact. Nevertheless, as the experiment has probably not been actually made, there is no harm in mentioning one or two examples of the same import, and which are ascertained by repeated observation. When caterpillars bred upon a tree, are shaken off, and fall for the first time upon the ground, they immediately regain the tree by crawling up as quick as they can. Again—it is a very general law of insects, that the grub feeds upon a food which the parent does not eat, and yet the latter makes provision for the grub. Thus the solitary wasp deposits its eggs, each in a hole, and then collects a certain number of green worms, which she rolls up and deposits in the same hole, over the egg. When the grub is hatched, it feeds upon these worms until transformed into a young wasp. And here two things are remarkable: first, the wasp itself never feeds upon the worm, or indeed on any animal food: and next, M. Reaumur found that she provides just enough of the worms to sustain the grub, till it becomes a fly, and changes its food. Our author dwells afterwards upon the application to the argument of the fact, that the parent insect never sees its young. The architecture of bees affords perhaps the most striking illustration; for those which have been taken without ever having any communication with the former race, build precisely in the accustomed manner. See the next note.—ENG. ED.

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[55] The manner in which the chicken breaks the egg is one of the most wonderful operations of instinct, and is a process marked by the uni-

But admit the sparrow by some means to know, that within that egg was concealed the principle of a future bird: from what chemist was she to learn, that *warmth* was necessary to bring it to maturity, or that the degree of warmth imparted by the temperature of her own body, was the degree required?

To suppose, therefore, that the female bird acts in this process from a sagacity and reason of her own, is to suppose her to arrive at conclusions which there are no premises to justify. If our sparrow, sitting upon her eggs, expect young sparrows to come out of them, she forms, I will venture to say, a wild and extravagant expectation, in opposition to present appearances and to probability. She must have penetrated into the order of Nature further than any faculties of ours will carry us; and it hath been well observed, that this deep sagacity, if it be sagacity, subsists in conjunction with great stupidity, even in relation to the same subject. "A chemical operation," says Addison, "could not be followed with greater art or diligence, than is seen in hatching a chicken; yet is the process carried on, without the least glimmering of thought or common sense. The hen will mistake a piece of chalk for an egg—is insensible of the increase or diminution of their number—does not distinguish between her own and those of another species—is frightened when her supposititious breed of ducklings take the water."

But it will be said, that what reason could not do for the bird, observation, or instruction, or tradition might. Now if it be true that a couple of sparrows, brought up

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formity of instincts. For as all bees build alike, with respect to the size of the cell and the angles at which its planes are inclined, so M. Reaumur found, that all chickens chip the shell in the same direction, from left to right; and that the circle in which they chip, invariably cuts the egg at right angles to its transverse axis, and not obliquely. The instrument which the chicken employs, is a small protuberance on its upper mandible, called the *bill-scale*, which has no other use, and accordingly drops off soon after the bird is hatched. If any one should consider this as a different operation in kind from those usually ascribed to instinct in animals that are formed, a little reflection will probably show him the impossibility of drawing any such line of distinction.—ENG. ED.]

from the first in a state of separation from all other birds, would build their nest, and brood upon their eggs, then there is an end of this solution. What can be the traditionary knowledge of a chicken, hatched in an oven?

Of young birds taken in their nests, a few species breed when kept in cages; and they which do so, build their nests nearly in the same manner as in the wild state, and sit upon their eggs. This is sufficient to prove an instinct, without having recourse to experiments upon birds hatched by artificial heat, and deprived from their birth of all communication with their species; for we can hardly bring ourselves to believe, that the parent bird informed her unfledged pupil of the history of her gestation, her timely preparation of a nest, her exclusion of the eggs, her long incubation, and of the joyful eruption at last of her expected offspring: all which the bird in the cage must have learnt in her infancy, if we resolve her conduct into *institution*.

Unless we will rather suppose that she remembers her own escape from the egg—had attentively observed the conformation of the nest in which she was nurtured—and had treasured up her remarks for future imitation; which is not only extremely improbable (for who that sees a brood of callow birds in their nest can believe that they are taking a plan of their habitation?) but leaves unaccounted for one principal part of the difficulty, "the preparation of the nest before the laying of the egg." This she could not gain from observation in her infancy.

It is remarkable also, that the hen sits upon eggs which she has laid without any communication with the male, and which are, therefore, necessarily unfruitful. That secret she is not let into. Yet if incubation had been a subject of instruction or of tradition, it should seem that this distinction would have formed part of the lesson: whereas the instinct of Nature is calculated for a state of nature—the exception here alluded to, taking place chiefly, if not solely, amongst domesticated fowls, in which Nature is forced out of her course.

There is another case of oviparous economy, which is still less likely to be the effect of education than it is even in birds, namely, that of *moths* and *butterflies*, which deposit their eggs in the precise substance—that of a cabbage, for example—from which, not the butterfly herself, but the caterpillar which is to issue from her egg, draws its appropriate food. The butterfly cannot taste the cabbage; cabbage is no food for her; yet in the cabbage, not by chance, but studiously and electively, she lays her eggs. There are, amongst many other kinds, the willow-caterpillar and the cabbage-caterpillar; but we never find upon a willow the caterpillar which eats the cabbage, nor the converse. This choice, as appears to me, cannot in the butterfly proceed from instruction. She had no teacher in her caterpillar state. She never knew her parent. I do not see, therefore, how knowledge acquired by experience, if it ever were such, could be transmitted from one generation to another. There is no opportunity either for instruction or imitation. The parent race is gone, before the new brood is hatched. And if it be original reasoning in the butterfly, it is profound reasoning indeed. She must remember her caterpillar state, its tastes and habits, of which memory she shows no signs whatever. She must conclude from analogy, (for here her recollection cannot serve her,) that the little round body which drops from her abdomen will, at a future period, produce a living creature, not like herself, but like the caterpillar which she remembers herself once to have been. Under the influence of these reflections, she goes about to make provision for an order of things, which she concludes will some time or other take place. And it is to be observed, that not a few out of many, but that all butterflies argue thus; all draw this conclusion; all act upon it.

But suppose the address, and the selection, and the plan, which we perceive in the preparations which many irrational animals make for their young, to be traced to some probable origin, still there is left to be accounted for, that which is the source and foundation of these phenomena, that which sets the whole at work, the στοργη, the parental affection, which I contend to be inexplicable upon any other hypothesis than that of instinct.

For we shall hardly, I imagine, in brutes, refer their conduct towards their offspring to a sense of duty or of decency, a care of reputation, a compliance with public manners, with public laws, or with rules of life built upon a long experience of their utility. And all attempts to account for the parental affection from association, I think, fail. With what is it associated? Most immediately with the throes of parturition, that is, with pain, and terror, and disease. The more remote, but not less strong association, that which depends upon analogy, is all against it. Every thing else which proceeds from the body is cast away and rejected. In birds, is it the egg which the hen loves? or is it the expectation which she cherishes of a future progeny, that keeps her upon her nest? What cause has she to expect delight from her progeny? Can any rational answer be given to the question, why, prior to experience, the brooding hen should look for pleasure from her chickens? It does not, I think, appear that the cuckoo ever knows her young; yet, in her way, she is as careful in making provision for them as any other bird. She does not leave her egg in every hole.

The salmon suffers no surmountable obstacle to oppose her progress up the stream of fresh rivers. And what does she do there? She sheds a spawn, which she immediately quits in order to return to the sea; and this issue of her body she never afterwards recognises in any shape whatever. Where shall we find a motive for her efforts and her perseverance? Shall we seek it in argumentation, or in instinct? The violet crab of Jamaica performs a fatiguing march of some months' continuance, from the mountains to the seaside. When she reaches the coast, she casts her spawn into the open sea, and sets out upon her return home.

Moths and butterflies, as hath already been observed, seek out for their eggs those precise situations and substances, in which the offspring caterpillar will find its appropriate food. That dear caterpillar the parent butterfly must never see. There are no experiments to prove, that she would retain any knowledge of it if she did. How shall we account for her conduct? I do not mean for her art and judgement, in selecting and securing a maintenance for her young, but for the impulse upon which she acts. What should induce her to exert any art, or judgement, or choice, about the matter? The undisclosed grub, the animal which she is destined not to know, can hardly be the object of a particular affection, if we deny the influence of instinct. There is nothing, therefore, left to her, but that of which her nature seems incapable, an abstract anxiety for the general preservation of the species—a kind of patriotism—a solicitude least the butterfly race should cease from the creation.

Lastly, the principle of association will not explain the discontinuance of the affection when the young animal is grown up. Association operating in its usual way would rather produce a contrary effect. The object would become more necessary by habits of society; whereas, birds and beasts, after a certain time, banish their offspring, disown their acquaintance, seem to have even no knowledge of the objects which so lately engrossed the attention of their minds, and occupied the industry and labor of their bodies. This change, in different animals, takes place at different distances of time from the birth; but the time always corresponds with the ability of the young animal to maintain itself; never anticipates it. In the sparrow tribe, when it is perceived that the young brood can fly and shift for themselves, then the parents forsake them for ever; and, though they continue to live together, pay them no more attention than they do to other birds in the same flock.* I believe the same thing is true of all gregarious quadrupeds.[56]

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* Goldsmith's Natural History, vol. iv. p. 244.

[56] In the natural and instinctive feelings of man, as contradistinguished from those which have been modified by reason, something of the same kind may be observed. The mutual relation of protection and dependence, produced by power and weakness, is of this description. A helpless infant excites much stronger sympathy in the mother than the child that can shift for itself; and hence the partiality, accompanied by

In this part of the case, the variety of resources, expedients, and materials, which animals of the same species are said to have recourse to, under different circumstances, and when differently supplied, makes nothing against the doctrine of instincts. The thing which we want to account for, is the propensity. The propensity being there, it is probable enough that it may put the animal upon different actions, according to different exigencies. And this adaptation of resources may look like the effect of art and consideration, rather than of instinct; but still the propensity is instinctive. For instance, suppose what is related of the woodpecker to be true, that in Europe she deposits her eggs in cavities which she scoops out in the trunks of soft or decayed trees, and in which cavities the eggs lie concealed from the eye, and in some sort safe from the hand of man, but that, in the forests of Guinea and the Brazils, which man seldom frequents, the same bird hangs her nest on the twigs of tall trees, thereby placing them out of the reach of *monkeys* and *snakes*—*i. e.*, that in each situation she prepares against the danger which she has most occasion to apprehend. Suppose, I say, this to be true, and to be alleged, on the part of the bird that builds these nests, as evidence of a reasoning and distinguishing precaution: still the question returns, whence the propensity to build at all?

Nor does parental affection accompany generation by any universal law of animal organization, if such a thing were intelligible. Some animals cherish their progeny with the most ardent fondness, and the most assiduous attention; others entirely neglect them; and this distinction always meets the constitution of the young animal, with respect to its wants and capacities. In many, the parental care extends to the young animal; in others, as in all oviparous fish, it is confined to the egg, and even as to that, to the disposal of it in its proper element. Also, as there is generation without parental affection, so is there parental instinct, or what exactly resembles it,

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blindness to defects, which most parents entertain towards children whose natural deficiency, whether bodily or mental, throws them on their care long after the season of infancy.—Eng. Ed.

without generation. In the bee tribe, the grub is nurtured neither by the father nor the mother, but by the neutral bee. Probably the case is the same with ants.

I am not ignorant of the theory which resolves instinct into sensation, which asserts that what appears to have a view and relation to the future, is the result only of the present disposition of the animal's body, and of pleasure or pain experienced *at the time.* Thus the incubation of eggs is accounted for, by the pleasure the bird is supposed to receive, from the pressure of the smooth convex surface of the shells against the abdomen, or by the relief which the mild temperature of the egg may afford to the heat of the lower part of the body, which is observed at this time to be increased beyond its usual state. This present gratification is the only motive with the hen for sitting upon her nest; the hatching of the chickens is, with respect to her, an accidental consequence. The affection of viviparous animals for their young is, in like manner, solved, by the relief, and perhaps the pleasure, which they perceive from giving suck. The young animal's seeking, in so many instances, the teat of its dam, is explained from its sense of smell, which is attracted by the odor of milk. The salmon's urging its way up the stream of fresh-water rivers, is attributed to some gratification or refreshment which, in this particular state of the fish's body, she receives from the change of element. Now of this theory it may be said,

First, that of the cases which require solution, there are few to which it can be applied with tolerable probability; that there are none to which it can be applied without strong objections, furnished by the circumstances of the case. The attention of the cow to its calf, and of the ewe to its lamb, appear to be prior to their sucking. The attraction of the calf or lamb to the teat of the dam, is not explained by simply referring it to the sense of smell. What made the scent of milk so agreeable to the lamb that it should follow it up with its nose, or seek with its mouth the place from which it proceeded? No observation, no experience, no argument could teach the new-dropped animal, that the substance from which the scent issued was the material of its food. It had never tasted milk before its birth. None of the animals which are not designed for that nourishment ever offer to suck, or to seek out any such food. What is the conclusion, but that the sugescent parts of animals are fitted for their use, and the knowledge of that use put into them?

We assert, secondly, that, even as to the cases in which the hypothesis has the fairest claim to consideration, it does not at all lessen the force of the argument for intention and design. The doctrine of instinct is that of appetencies, *superadded* to the constitution of an animal, for the effectuating of a purpose beneficial to the species. The above-stated solution would derive these appetencies from organization; but then, this organization is not less specifically, not less precisely, and, therefore, not less evidently adapted to the same ends, than the appetencies themselves would be upon the old hypothesis. In this way of considering the subject, sensation supplies the place of foresight: but this is the effect of contrivance on the part of the Creator. Let it be allowed, for example, that the hen is induced to brood upon her eggs by the enjoyment or relief which, in the heated state of her abdomen, she experiences from the pressure of round smooth surfaces, or from the application of a temperate warmth. How comes this extraordinary heat or itching, or call it what you will, which you suppose to be the cause of the bird's inclination, to be felt just at the time when the inclination itself is wanted: when it tallies so exactly with the internal constitution of the egg, and with the help which that constitution requires in order to bring it to maturity? In my opinion, this solution, if it be accepted as to the fact, ought to increase, rather than otherwise, our admiration of the contrivance.[57] A gardener, lighting up his stoves, just when he wants to force his fruit, and when his trees require the heat, gives not a more certain evidence of design. So again; when a male and female sparrow come together, they do not meet to confer upon the expediency of perpetuating their species. As an abstract proposition, they care not the value of a barleycorn whether the species be perpetuated, or not: they follow their sensations, and all those consequences ensue, which the wisest counsels could have dictated, which the most solicitous care of futurity, which the most anxious concern for the sparrow-world, could have produced. But how do these consequences ensue? The sensations, and the constitution upon which they depend, are as manifestly directed to the purpose which we see fulfilled by them; and the train of intermediate effects, as manifestly laid and planned with a view to that purpose: that is to say, design is as completely evinced by the phenomena, as it would be, even if we suppose the

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[57] Whether we regard the argument of existence, or of attributes, the truth here glanced at is of extreme importance, and it pervades the whole of Natural Theology. It will be more fully illustrated in the notes to the subsequent chapters. When skeptics think they have destroyed one reason, for believing in the skill, or in the goodness of the Deity, by an explanation of the means used for producing some given effect, they only remove our admiration and our gratitude from one point to another, and often augment both the one and the other. Suppose it

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were discovered, contrary to all probability, that the bee makes the angles 109° 28′ and 70° 32′ by means of some bodily conformation which secures this result,—some form of its own parts answering to those angles, if such a thing can be conceived; the wonder is only removed from the working of the insect without a tool, to its using a tool provided for it, by the intelligence which had solved the problem of maxima and minima, whence this conformation is a corollary. Again,—the loss of one sense, as the sight, quickens our perceptions through the organs of those senses which remain,—as touch and hearing. It is most probable that this effect is produced by the influence of habit, and has no direct connexion with the loss sustained. But habit might have had no such effect, and it might have blunted instead of sharpening; its effect tends to lessen the evil of the loss sustained; and it produces this advantage just as much as if the compensation had been the direct and immediate consequence of that loss. We are not here arguing the question of evil: that will be treated of hereafter, and it is common to both suppositions; but to the case of immediate and mediate compensation. Again,—suppose, in generalizing, we could resolve all intellectual phenomena into some one principle, as association,—all moral into some other, as habit,—all physical into some third, as gravitation;—nay, suppose the doctrines of some materialists to prevail, and that all mental and all physical phenomena were resolvable into the operations of some subtile fluid,—this would surely not weaken the arguments for the unity of the Deity, if indeed it did not rather strengthen them; it would in no degree detract from our conviction of his skill, nor even of the variety of its operations; and it would leave the argument as to goodness exactly where it stood before.—Eng. Ed.

operations to begin, or to be carried on, from what some will allow to be alone properly called instincts, that is, from desires directed to a future end, and having no accomplishment or gratification distinct from the attainment of that end.

In a word: I should say to the patrons of this opinion, Be it so; be it that those actions of animals which we refer to instinct are not gone about with any view to their consequences, but that they are attended in the animal with a present gratification, and are pursued for the sake of that gratification alone; what does all this prove, but that the *prospection*, which must be somewhere, is not in the animal, but in the Creator?

In treating of the parental affection in brutes, our business lies rather with the origin of the principle, than with the effects and expressions of it. Writers recount these with pleasure and admiration. The conduct of many kinds of animals towards their young has escaped no observer, no historian of Nature. "How will they caress them," says Derham, "with their affectionate notes; lull and quiet them with their tender parental voice; put food into their mouths; cherish and keep them warm; teach them to pick, and eat, and gather food for themselves; and, in a word, perform the part of so many nurses, deputed by the Sovereign Lord and Preserver of the world to help such young and shiftless creatures!" Neither ought it, under this head, to be forgotten, how much the instinct *costs* the animal which feels it; how much a bird, for example, gives up by sitting upon her nest; how repugnant it is to her organization, her habits, and her pleasures. An animal, formed for liberty, submits to confinement, in the very season when every thing invites her abroad: what is more, an animal delighting in motion, made for motion, all whose motions are so easy, and so free, hardly a moment, at other times, at rest, is, for many hours of many days together, fixed to her nest, as close as if her limbs were tied down by pins and wires. For my part, I never see a bird in that situation but I recognise an invisible hand, detaining the contented prisoner from her fields and groves, for the purpose, as the event proves, the most worthy of the sacrifice, the most important, the most beneficial.

But the loss of liberty is not the whole of what the procreant bird suffers. Harvey tells us, that he has often found the female wasted to skin and bone by sitting upon her eggs.

One observation more, and I will dismiss the subject. The *pairing* of birds, and the *non-pairing* of beasts, forms a distinction between the two classes, which shows that the conjugal instinct is modified with a reference to utility, founded on the condition of the offspring. In quadrupeds, the young animal draws its nutriment from the body of the dam. The male parent neither does, nor can contribute any part to its sustentation. In the winged race, the young bird is supplied by an importation of food, to procure and bring home which, in a sufficient quantity for the demand of a numerous brood, requires the industry of both parents. In this difference, we see a reason for the vagrant instinct of the quadruped, and for the faithful love of the feathered mate.

CHAPTER XIX.

INSECTS.

We are not writing a system of natural history; therefore we have not attended to the classes, into which the subjects of that science are distributed. What we had to observe concerning different species of animals, fell easily, for the most part, within the divisions which the course of our argument led us to adopt. There remain, however, some remarks upon the *insect* tribe, which could not properly be introduced under any of these heads; and which, therefore, we have collected into a chapter by themselves.

The structure and the use of the parts, of insects, are less understood than that of quadrupeds and birds, not only by reason of their minuteness, or the minuteness of their parts, (for that minuteness we can, in some measure, follow with glasses,) but also by reason of the remoteness of their manners and modes of life, from those of larger animals. For instance: Insects, under all their varieties of form, are endowed with *antennæ*,[58] which is the name given to those long feelers that rise from each side of the head: but to what common use or want of the insect kind, a provision so universal is subservient, has not yet been ascertained; and it has not been ascertained, because it admits not of a clear, or very probable, comparison, with any organs which we possess ourselves, or with the organs of animals which resemble ourselves in their functions and faculties, or with which we are better acquainted than we are with insects. We want a ground of analogy. This difficulty stands in our way as to some particulars in the insect constitution, which we might wish to be acquainted with. Nevertheless, there are many contrivances in the bodies of insects, neither dubious in their use, nor obscure in their structure, and most properly mechanical. These form parts of *our* argument.

I. The *elytra*, or scaly wings of the genus of scarabæus or beetle, furnish an example of this kind. The true wing of the animal is a light, transparent membrane, finer than the finest gauze, and not unlike it. It is also, when expanded, in proportion to the size of the animal, very large. In order to protect this delicate structure, and, perhaps, also to preserve it in a due state of suppleness and humidity, a strong hard case is given to it, in the shape of the horny wing which we call the elytron. When the animal is at rest, the gauze wings lie folded up under this impenetrable shield. When the beetle prepares for flying, he raises the integument, and spreads out his thin membrane to the air. And it cannot be observed without admiration, what a tissue of cordage, *i. e.*, of muscular tendons, must run in various and complicated, but determinate directions, along this fine surface, in order to enable the animal, either to gather it up into a certain precise form, whenever it desires to place its wings under the shelter which Nature hath given to them; or to expand again their folds when wanted for action.

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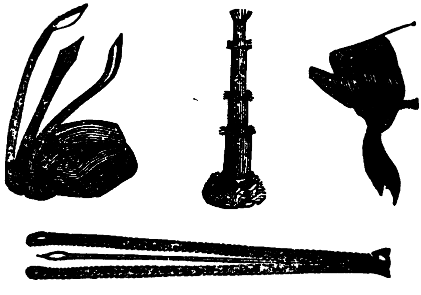
[58] The most scientific entomologists consider the antennæ of insects to be organs of hearing; this is the opinion of those who have minutely examined their structure; whereas very many entomologists contend, that the antennæ are organs of feeling, observing that many insects are constantly touching surrounding objects with them, such as the bee tribe, ichneumonidæ, &c. The argument used against the latter opinion is, that although many insects do undoubtedly touch surrounding objects with their antennæ, yet many scrupulously avoid so doing, such as the butterfly and moth tribe, the Lamellicorn beetles, &c. When, however, we are asked the question, what is hearing as distinguished from feeling, we find it difficult to draw any line. Are they not mere modifications of the same thing? and, as the antennæ of insects are so exceedingly variable in form, may they not be used as organs of touch in some, and of hearing in others?—ENG. ED.

In some insects, the elytra cover the whole body; in others, half; in others, only a small part of it; but in all, they completely hide and cover the true wings. Also,

Many, or most of the beetle species, lodge in holes in the earth, environed by hard, rough substances, and have frequently to squeeze their way through narrow passages; in which situation, wings so tender, and so large, could scarcely have escaped injury, without both a firm covering to defend them, and the capacity of collecting themselves up under its protection.

II. Another contrivance, equally mechanical, and equally clear, is the *awl*, or borer, fixed at the tails of various



species of flies; and with which they pierce, in some cases, plants; in others, wood; in others, the skin and flesh of animals; in others, the coat of the chrysalis of insects of a different species from their own; and in others, even lime, mortar, and stone.[59] I need not add, that having pierced the substance, they deposit their eggs in the hole. The descriptions which naturalists give of this organ are such as the following: It is a sharp-pointed instrument, which, in its inactive state, lies concealed in the extremity of the abdomen, and which the animal draws out at pleasure, for the purpose of making a puncture in the leaves, stem, or bark, of the particular plant, which is suited to the nourishment of its young. In a sheath, which divides and opens whenever the organ is used, there is enclosed a compact, solid, dentated stem, along which runs a *gutter* or *groove*, by which groove, after the penetration is effected, the egg, assisted, in some cases by a peristaltic motion, passes to its destined lodgement. In the œstrum or gadfly, the wimble [or egg depositor] *draws out* like the pieces of a spy-glass: the last piece is armed with three hooks, and is able to bore through the hide of an ox. Can any thing more be necessary to display the mechanism, than to relate the fact?

III. The *stings*[60] of insects, though for a different purpose, are, in their structure, not unlike the piercer. The sharpness to which the point in all of them is wrought; the temper and firmness of the substance of which it is composed; the strength of the muscles by which it is darted out, compared with the smallness and weakness of the insect, and with the soft and friable texture of the rest of the body,—are properties of the sting to be noticed, and not a little to be admired. The sting of a *bee* will pierce through a goat-skin glove. It penetrates the human flesh more readily than the finest point of a needle. The *action* of the sting affords an example of the union of chemistry and mechanism, such as, if it be not a proof of contrivance, nothing is. First, as to the chemistry: how highly concentrated must be the *venom*, which, in so small a quantity, can produce such powerful effects! And in the bee we may observe, that this venom is made from *honey*, the only food of the insect, but the last material from which I should have expected that an exalted poison could, by any process or digestion whatsoever, have been prepared. In the next place, with respect to the mechanism, the sting is not a simple but a compound instrument. The visible sting, though drawn to a point exquisitely sharp, is in strictness only a sheath, for, near to the extremity, may be perceived by the microscope two minute orifices, from which orifices, in the act of stinging, and, as it should seem, after the point of the main sting has buried itself in the flesh, are launched out two subtile rays, which may be called the true or proper stings, as being those through which the poison is infused into the puncture already made by the exterior sting. I have said, that chemistry and mechanism are here *united*: by which observation I meant, that all this machinery would have been useless, *telum imbelle*, if a supply of poison, intense in quality, in proportion to the smallness of the drop, had not been furnished to it by the chemical elaboration which was carried on in the insect's body; and that, on the other hand, the poison, the result of this process, could not have attained its effect, or reached its enemy, if, when it was collected at the extremity of the abdomen, it had not found there a machinery fitted to conduct it to the external situations in which it was to operate, *viz.*, an awl to bore a hole, and a syringe to inject the fluid. Yet these attributes, though combined in their action, are independent in their origin. The venom does not breed the sting; nor does the sting concoct the venom.

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[59] There is not any accredited instance of any insects perforating so hard a substance as stone, with the "awl or borer" fixed at the tail. This instrument, technically called ovipositor, is excessively variable in its structure, being scarcely alike in any two species: the description given will answer for that of the saw-fly, (*Tenthredo.*)—ENG. ED.

[60] The stings of insects are also used as ovipositors.—ENG. ED.

IV. The *proboscis*,[61] with which many insects are endowed, comes next in order to be considered. It is a tube attached to the head of the animal; in the bee, it is

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[61] The part called proboscis in the bee consists of a central stalk, or tongue, *a*, (Fig. 1,) and four lateral pieces, or jaws, two of which spring from the base, and two have their origin near the middle. The apical half of the stalk is soft and flexible, rather flat, and covered with minute hairs: it is chiefly this part of the proboscis which is used in collecting honey. Honey is not sucked up, as is generally supposed, but licked up, and then conveyed to the œsophagus. The four lateral pieces when closed form a sheath to protect the tongue, and other parts of the central stalk. Fig. 2, represents the profile of a butterfly's head; *a* is the

Fig. 1.

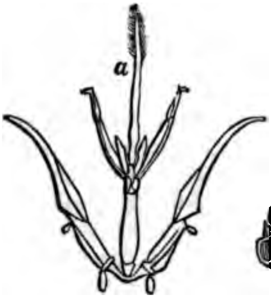
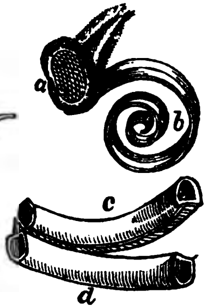


Fig. 2.



composed of two pieces, connected by a joint: for, if it were constantly extended, it would be too much exposed to accidental injuries; therefore, in its indolent state, it is doubled up by means of the joint, and in that position lies secure under a scaly pent-house.[62] In many species of the butterfly, the proboscis, when not in use, is coiled up like a watch-spring. In the same bee, the proboscis serves the office of the mouth, the insect having no other;[63] and how much better adapted it is, than a mouth would be, for the collecting of the proper nourishment of the animal, is sufficiently evident. The food of the bee is the nectar of flowers; a drop of syrup, lodged deep in the bottom of the corollæ, in the recesses of the petals, or down the neck of a monopetalous glove. Into these cells, the bee thrusts its long, narrow pump, through the cavity of which it sucks up this precious fluid, inaccessible to every other approach. It is observable also, that

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compound eye, and *b* the proboscis partially unfolded; *c* and *d* show portions of the tubes forming the proboscis highly magnified.—ENG. ED.

[62] There is an indentation in the upper side of the head, to receive the proboscis when folded up.—ENG. ED.

[63] A bee has the same number of parts to its mouth as any other insect; the only difference between that of a bee and a beetle is, that some of the parts are more developed in the former: *viz.*, the labium, tongue, and maxillæ.—ENG. ED.

the plant is not the worse[64] for what the bee does to it. The harmless plunderer rifles the sweets, but leaves the flower uninjured. The ringlets of which the proboscis of the bee is composed, the muscles by which it is extended and contracted, form so many microscopical wonders. The agility also with which it is moved, can hardly fail to excite admiration. But it is enough for our purpose to observe, in general, the suitableness of the structure to the use, of the means to the end, and especially the wisdom by which Nature has departed from its most general analogy, (for animals being furnished with mouths are such,) when the purpose could be better answered by the deviation.

In some insects the proboscis, or tongue, or trunk, is shut up in a sharp-pointed sheath, which sheath,[65] being of a much firmer texture than the proboscis itself, as well as sharpened at the point, pierces the substance which contains the food, and then *opens within the wound*, to allow the enclosed tube, through which the juice is extracted, to perform its office. Can any mechanism be plainer than this is, or surpass this ?

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[64] Bees are essential to the fructification of many sorts of plants, for it is by them that the farina is carried from the male to the female flowers; and as some flowers yield a much greater quantity of honey than others, it might perhaps be imagined that those yielding little, and yet depending upon the bees for their fructification, might often be barren. No such defects, however, are to be found: the structure of the proboscis varies considerably in different species of bees, so that all bees cannot collect indiscriminately from any honey-yielding plant. One great tribe of bees (the *apidæ*) collect their honey for the most part from bell-shaped flowers, such as the blind-nettle, &c.; their long proboscis enabling them to reach the bottom of the bells. Another tribe, having the proboscis short, are obliged to collect from flowers of a different shape. There is yet another circumstance which leads the different sorts of bees to visit a variety of flowers: *viz.*, that they do not feed their larvæ on the same substance. If we examine the cells of some, (the *andrænidæ*,) we find that the food stored up for the young consists of a ball of farina, which has scarcely any admixture of honey: these bees would naturally seek those flowers which yield the most farina; whereas in others, (the *apidæ*,) honey with very little farina, is stored up for the young.—ENG. ED.

[65] The mouth of the common flea (*Pulex irritans*) is of this nature; it is composed of seven pieces, a pair of *mandibles*, a pair of *maxillæ*, two *palpi* or feelers, and a *tongue*. The uses of these pieces appear to be as follows:—the *mandibles*, which are short, strong, and sharp, are to cut through the outer skin; the *maxillæ*, which are long, and shaped like lancets, are to pierce still deeper so as to cause bleeding: the *tongue* is then used to lick and convey the blood to the œsophagus; and the *palpi* are to direct these operations, conveying information to the animal by feeling or touch. These same seven parts (forming the mouth and technically called *trophi*) are to be found in almost all insects, but

V. The *metamorphosis* of insects from grubs into moths and flies, is an astonishing process. A hairy caterpillar is transformed into a butterfly. Observe the change. We have four beautiful wings where there were none before—a tubular proboscis in the place of a mouth with jaws and teeth,[66] six long legs instead of fourteen feet. In

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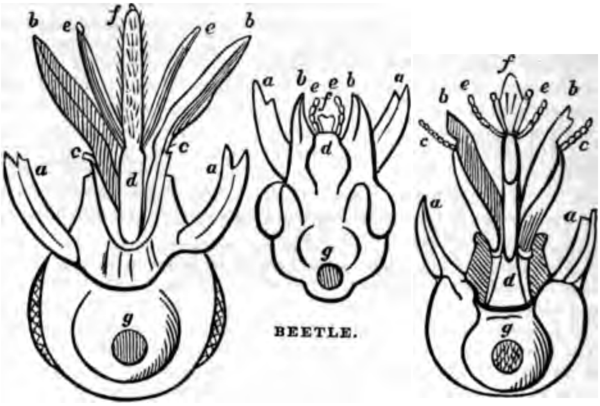
constructed in different ways, to suit the various habits of the species.—Eng. Ed.

[66] The mouth of the caterpillar, or larva state of insects, has, in the greater portion of the species, the same number of parts as that of the perfect insect. In the pupa state some of these parts become nearly or quite obliterated, whilst others are much more developed to suit the habits of the animal in its next or perfect state of existence ; and thus, of course, in some instances, where there is but little difference between the habits of the larva and those of the perfect insect, there is likewise but little difference in the structure of the mouth, as, for instance, in locusts, grasshoppers, and cockroaches.

In the butterfly tribe, the maxillæ or under-jaws of the caterpillar be-



BEETLE.

HUMBLE BEE.

BEE.

a, *a*, mandibles ; *c*, *c*, maxillary palpi ; *e*, *e*, labial palpi ;
b, *b*, maxillæ ; *d*, *d*, labium ; *f*, tongue ; *g*, neck.

another case we see a white, smooth, soft worm, turned into a black, hard, crustaceous beetle with gauze wings. These, as I said, are astonishing processes, and must require, as it should seem, a proportionably artificial apparatus. The hypothesis which appears to me most probable is, that, in the grub, there exist at the same time three animals, one within another, all nourished by the same digestion, and by a communicating circulation, but in different stages of maturity.[67] The latest discoveries made by naturalists seem to favor this supposition. The insect, already equipped with wings, is descried under the

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come in the perfect insect elongated into two tubes, (see Cut,) which may be joined together at the pleasure of the animal, by means of projecting ridges, (furnished with a sort of hook somewhat like the laminæ of feathers,) in such a way as to leave a third tube between the two. It is through the central tube that the nectar is pumped or sucked up; the two outer tubes, Reaumur imagines, are for the reception of air; if this be the case, it may possibly be that air which is discharged from the central tube to create the necessary vacuum. The mandibles, or upper-jaws, and other parts conspicuous in the caterpillar, are to be found only in a rudimentary state in the butterfly; yet they do exist.—Eng. Ed.

[67] The following observations do not exactly support the opinion of Dr. Paley. It is more probable that the parts which are to appear in the perfect insect do *not* exist in the larva, where there is not much difference between the larva and pupa, excepting at the time just previous to its becoming a pupa, at which time the larva is motionless and torpid. The caterpillar of a moth, when about to turn into a pupa, provides for the protection of the latter state, either by surrounding itself with a web, or by some other means. Soon after this is accomplished, the caterpillar becomes motionless, or nearly so; it can neither eat nor crawl. At this time, and *not before*, the parts of the pupa are forming within the skin of the caterpillar, which may be easily seen by dissection. When the difference between the larva and the perfect insect is great, this is always the case, and the pupa is passive; but when the difference is not so considerable, the case is different. The larva of a grasshopper scarcely differs from the perfect insect it is to become, except in wanting wings; the pupa differs only in having rudimentary instead of perfect wings; it casts its skin; it is then the perfect insect, excepting that the wings are crippled, and these very rapidly expand. In this latter case it is seen, that there is but little difference between the three stages, and the change from the caterpillar to the moth is very great, and takes place only during the torpid state of the former, which state is to allow of its taking place. In the case of the grasshopper, where the changes are but slight, we should imagine but little of this torpidity would be required; and such appears to be the case, for the pupæ of grasshoppers, and allied insects, are always as active as either the larva or perfect insect.—Eng. Ed.

membranes both of the worm and nymph. In some species, the proboscis, the antennæ, the limbs, and wings of the fly, have been observed to be folded up within the body of the caterpillar; and with such nicety, as to occupy a small space only, under the two first wings. This being so, the outermost animal, which, besides its own proper character, serves as an integument to the other two, being the furthest advanced, dies, as we suppose, and drops off first. The second, the pupa or chrysalis, then offers itself to observation. This also, in its turn, dies; its dead and brittle husk falls to pieces, and makes way for the appearance of the fly or moth. Now if this be the case, or indeed whatever explication be adopted, we have a prospective contrivance of the most curious kind; we have organizations *three deep*, yet a vascular system which supplies nutrition, growth, and life to all of them together.

VI. Almost all insects are oviparous. Nature keeps her butterflies, moths, and caterpillars locked up during the winter, in their egg-state; and we have to admire the various devices to which, if we may so speak, the same Nature hath resorted, for the *security* of the egg. Many insects enclose their eggs in a silken web; others cover them with a coat of hair, torn from their own bodies; some glue them together; and others, like the moth of the silkworm, glue them to the leaves upon which they are deposited, that they may not be shaken off by the wind, or washed away by rain. Some, again, make incisions into leaves, and hide an egg in each incision; whilst some envelope their eggs with a soft substance, which forms the first aliment of the young animal; and some again make a hole in the earth, and having stored it with a quantity of proper food, deposit their eggs in it. In all which we are to observe, that the expedient depends not so much upon the address of the animal, as upon the physical resources of his constitution.

The art also with which the young insect is *coiled up* in the egg, presents, where it can be examined, a subject of great curiosity. The insect, furnished with all the members which it ought to have, is rolled up into a form which seems to contract it into the least possible space; by which contraction, notwithstanding the smallness of the egg, it has room enough in its apartment, and to spare. This folding of the limbs appears to me to indicate a special direction; for, if it were merely the effect of compression, the collocation of the parts would be more various than it is. In the same species, I believe, it is always the same.

These observations belong to the whole insect tribe, or to a great part of them. Other observations are limited to fewer species, but not, perhaps, less important or satisfactory.

I. The organization in the abdomen of the *silkworm*, or *spider*, whereby these insects form their *thread*, is as incontestably mechanical as a wire-drawer's mill. In the body of the silkworm are two bags, remarkable for their form, position, and use. They wind round the intestine; when drawn out they are ten inches in length, though the animal itself be only two. Within these bags is collected a glue; and, communicating with the bags, are two paps or outlets, perforated like a grater by a number of small holes. The glue or gum, being passed through these minute apertures, forms hairs of almost imperceptible fineness; and these hairs, when joined, compose the silk which we wind off from the cone in which the silkworm has wrapped itself up: in the spider, the web is formed from this thread. In both cases, the extremity of the thread, by means of its adhesive quality, is first attached by the animal to some external hold; and the end being now fastened to a point, the insect, by turning round its body, or by receding from that point, draws out the thread, through the holes above described, by an operation, as hath been observed, exactly similar to the drawing of wire. The thread, like the wire, is formed by the hole through which it passes. In one respect there is a

difference. The wire is the metal unaltered, except in figure. In the animal process, the nature of the substance is somewhat changed, as well as the form; for, as it exists within the insect, it is a soft, clammy gum, or glue. The thread acquires, it is probable, its firmness and tenacity from the action of the air upon its surface, in the moment of exposure; and a thread so fine is almost all surface. This property, however, of the paste is part of the contrivance.

The mechanism itself consists, of the bags or reservoirs into which the glue is collected, and of the external holes communicating with these bags; and the action of the machine is seen in the forming of a thread, as wire is formed, by forcing the material already prepared through holes of proper dimensions. The secretion is an act too subtile for our discernment, except as we perceive it by the produce. But one thing answers to another; the secretory glands to the quality and consistence required in the secreted substance; the bag to its reception. The outlets and orifices are constructed, not merely for relieving the reservoirs of their burden, but for manufacturing the contents into a form and texture of great external use, or rather, indeed, of future necessity, to the life and functions of the insect.

II. BEES, under one character or other, have furnished every naturalist with a set of observations. I shall, in this place, confine myself to one; and that is, the *relation* which obtains between the wax and the honey. No person who has inspected a bee-hive, can forbear remarking how commodiously the honey is bestowed in the comb; and, amongst other advantages, how effectually the fermentation of the honey is prevented, by distributing it into small cells. The fact is, that when the honey is separated from the comb, and put into jars, it runs into fermentation with a much less degree of heat, than what takes place in a hive. This may be reckoned a nicety; but, independently of any nicety in the matter, I would ask, what could the bee do with the honey if it had not the wax? how, at least, could it store it up for winter? The wax, therefore, answers a purpose with respect to the honey; and the honey constitutes that purpose with respect to the wax. This is the relation between them. But the two substances, though together of the greatest use, and without each other of little, come from a different origin. The bee finds the honey, but makes the wax. The honey is lodged in the nectaria of flowers, and probably undergoes little alteration—is merely collected; whereas the wax is a ductile, tenacious paste, made out of a dry powder,[68] not simply by kneading it with a liquid, but by a digestive process in the body of the bee. What account can be rendered of facts so circumstanced, but that the animal, being intended to feed upon honey, was, by a peculiar external configuration, enabled to procure it? That, moreover, wanting the honey when it could not be procured at all, it was further endued with the no less necessary faculty of constructing repositories for its preservation? Which faculty, it is evident, must depend primarily upon the capacity of providing suitable materials. Two distinct functions go to make up the ability. First, the power in the bee, with respect to wax, of loading the farina of flowers upon its thighs. Microscopic observers speak of the spoon-shaped appendages with which the thighs of bees are beset for this very purpose; but, inasmuch as the art and will of the bee may be supposed to be concerned in this operation, there is, secondly, that which doth not rest in art or will—a digestive faculty, which converts the loose powder into a stiff substance. This is a just account of the honey and the honey-comb; and this account, through every part, carries a creative intelligence along with it.

The *sting* also of the bee, has this relation to the honey, that it is necessary for the protection of a treasure, which invites so many robbers.

III. Our business is with mechanism. In the *panorpa* tribe of insects, there is a forceps in the tail of the male

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[63] The opinion of Huber, Hunter, and others, is, that wax is not made out of pollen, but from honey. Huber kept some bees confined, and fed them with honey only, and wax was secreted as usual. It is most likely that bees never eat farina, and that it is collected for the larvæ only.—ENG. ED.

insect, with which he catches and holds the female. Are a pair of pincers more mechanical than this provision in its structure? or is any structure more clear and certain in its design?

IV. St. Pierre tells us, that in a fly with six feet, (I do not remember that he describes the species,) the pair next the head, and the pair next the tail, have brushes at their extremities, with which the fly dresses, as there may be occasion, the anterior or the posterior part of its body; but that the middle pair have no such brushes, the situation of these legs not admitting of the brushes, if they were there, being converted to the same use. This is a very exact mechanical distinction.

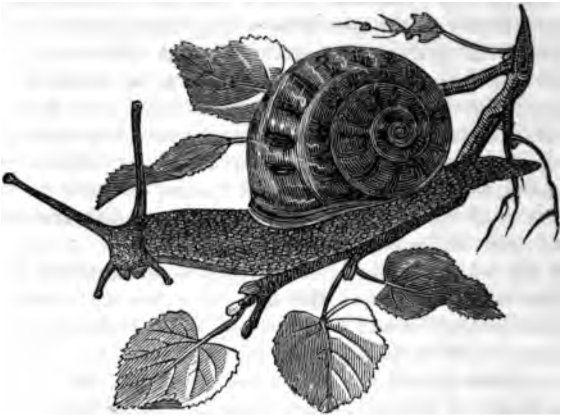
V. If the reader, looking to our distributions of science, wish to contemplate the chemistry as well as the mechanism of Nature, the insect creation will afford him an example. I refer to the light in the tail of a *glowworm.* Two points seem to be agreed upon by naturalists concerning it: first, that it is phosphoric; secondly, that its use is to attract the male insect. The only thing to be inquired after is the singularity, if any such there be, in the natural history of this animal, which should render a provision of this kind more necessary for it than for other insects. That singularity seems to be the difference which subsists between the male and the female, which difference is greater than what we find in any other species of animal whatever. The glowworm is a female *caterpillar*, the male of which is a *fly*, lively, comparatively small, dissimilar to the female in appearance, probably also as distinguished from her in habits, pursuits, and manners, as he is unlike in form and external constitution. Here then is the adversity of the case. The caterpillar cannot meet her companion in the air. The winged rover disdains the ground. They might never, therefore, be brought together did not this radiant torch direct the volatile mate to his sedentary female.

In this example, we also see the resources of art anticipated. One grand operation of chemistry is the making of phosphorus; and it was thought an ingenious device, to make phosphoric matches supply the place of lighted tapers. Now this very thing is done in the body of the glowworm. The phosphorus is not only made, but kindled, and caused to emit a steady and genial beam, for the purpose which is here stated, and which I believe to be the true one.

VI. Nor is the last the only instance that entomology affords, in which our discoveries, or rather our projects, turn out to be imitations of Nature. Some years ago, a plan was suggested of producing propulsion by reaction in this way: by the force of a steam-engine, a stream of water was to be shot out of the stern of a boat, the impulse of which stream upon the water in the river was to push the boat itself forward; it is, in truth, the principle by which sky-rockets ascend in the air. Of the use or practicability of the plan I am not speaking; nor is it my concern to praise its ingenuity; but it is certainly a contrivance. Now, if naturalists are to be believed, it is exactly the device which Nature has made use of, for the motion of some species of aquatic insects. The larva of the *dragon-fly*, according to Adams, swims by ejecting water from its tail—is driven forward by the reaction of water in the pool, upon the current issuing in a direction backward from its body.

VII. Again: Europe has lately been surprised by the elevation of bodies in the air, by means of a balloon. The discovery consisted in finding out a manageable substance, which was, bulk for bulk, lighter than air; and the application of the discovery was, to make a body composed of this substance bear up, along with its own weight, some heavier body which was attached to it. This expedient, so new to us, proves to be no other than what the Author of Nature has employed in the *gossamer spider*. We frequently see this spider's thread floating in the air, and extended from hedge to hedge across a road or brook of four or five yards width. The animal which forms the thread, has no wings wherewith to fly from one extremity to the other of this line, nor muscles to enable it to spring or dart to so great a distance: yet its Creator hath laid for it a path in the atmosphere; and after this manner. Though the animal itself be heavier than air, the thread which it spins from its bowels is specifically lighter. This is its *balloon.* The spider, left to itself, would drop to the ground; but being tied to its thread, both are supported. We have here a very peculiar provision; and to a contemplative eye it is a gratifying spectacle, to see this insect wafted on her thread, sustained by a levity not her own, and traversing regions which, if we examined only the body of the animal, might seem to have been forbidden to its nature.[69]

I must now crave the reader's permission to introduce into this place, for want of a better, an observation or two upon the tribe of animals, whether belonging to land or water, which are covered by *shells.*



[*Helix aspersa* of Müller,—common garden snail; but the cut represents what is called a left-handed shell, and a rarity.]

I. The *shells* of *snails* are a wonderful, a mechanical, and, if one might so speak concerning the works of Nature, an original contrivance. Other animals have their proper retreats, their hybernacula also, or winter-quarters, but the snail carries these about with him. He travels with his tent; and this tent, though, as was necessary, both light and thin, is completely impervious either to moisture or air. The young snail comes out of its egg with the shell upon its back; and the gradual enlargement which the shell receives, is derived from the slime excreted by the animal's skin. Now the aptness of this excretion to the purpose, its property of hardening into a shell, and the action, whatever it be, of the animal, whereby it avails itself of its gift, and of the constitution of its glands, (to say nothing of the work being commenced before the animal is born,) are things which can, with no probability, be referred to any other cause than to express design; and that not on the part of the animal alone, in which design, though it might build the house, it could not have supplied the material. The will of the animal could not determine the quality of the excretion. Add to which, that the shell of the snail, with its pillar and convolution, is a very artificial fabric; whilst a snail, as it should seem, is the most numb and unprovided of all artificers. In the midst of variety, there is likewise a regularity which could hardly be expected. In the same species of snail the number of turns is usually, if not always, the same. The sealing up of the mouth of the shell by the snail, is also well calculated for its warmth and security; but the cerate is not of the same substance with the shell.

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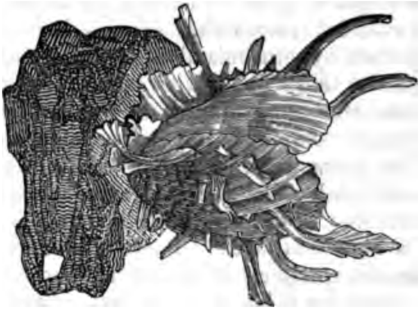
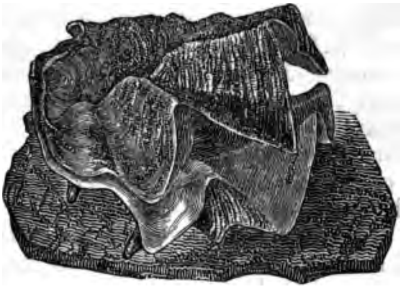
[69] It was at one time supposed, that the spider could project its thread through the air at will, in any direction, and thus attaching it to different bodies, move from one to the other. The observations more accurately made of late years, show that this power is not possessed by the animal, but that it requires the aid of a current of air to direct the thread. This correction, however, of the former opinion, in no way weakens the force of the argument in the text.—Eng. Ed.

II. Much of what has been observed of snails belongs to *shellfish* and their *shells*, particularly to those of the univalve kind; with the addition of two remarks—one of which is upon the great strength and hardness of most of these shells. I do not know whether, the weight being given, art can produce so strong a case as are some of these shells; which defensive strength suits well with the life of an animal, that has often to sustain the dangers of a stormy element, and a rocky bottom, as well as the attacks of voracious fish. The other remark is upon the property, in the animal excretion, not only of congealing,



[*Spondylus*—prickly oyster.]

but of congealing, or, as a builder would call it, ***setting***, in water, and into a cretaceous substance, firm and hard. This property is much more extraordinary, and, chemically speaking, more specific, than that of hardening in



[*Ostrea crista galli*, of Lamarck, *Mytilus crista galli* of Linnæus—the cock's-comb oyster.]

the air, which may be reckoned a kind of exsiccation, like the drying of clay into bricks.

III. In the *bivalve* order of shellfish, cockles, mussels, oysters, &c., what contrivance can be so simple, or so clear, as the insertion, at the back, of a tough tendinous substance, that becomes at once the ligament which binds

[*Cardium cardissa*—Venus's heart cockle.]

the two shells together, and the *hinge* upon which they open and shut ?

IV. The shell of a lobster's tail, in its articulations and overlappings, represents the jointed part of a coat of mail ; or rather, which I believe to be the truth, a coat of mail is an imitation of a lobster's shell. The same end is to be answered by both ; the same properties, therefore, are required in both, namely, hardness and flexibility—a covering which may guard the part without obstructing its motion. For this double purpose the art of man, expressly exercised upon the subject, has not been able to devise any thing better, than what Nature presents to his observation. Is not this therefore mechanism, which the mechanic, having a similar purpose in view, adopts ? Is the structure of a coat of mail to be referred to art ? Is the same structure of the lobster, conducing to the same use, to be referred to any thing less than art ?

Some who may acknowledge the imitation, and assent to the inference which we draw from it, in the instance before us, may be disposed, possibly, to ask, why such imitations are not more frequent than they are, if it be true, as we allege, that the same principle of intelligence, design, and mechanical contrivance was exerted, in the formation of natural bodies, as we employ in the making of the various instruments, by which our purposes are served ? The answers to this question are, first, that it seldom happens that precisely the same purpose, and no other, is pursued in any work which we compare of Nature and of art; secondly, that it still more seldom happens that we *can* imitate Nature, if we would. Our materials and our workmanship are equally deficient. Springs and wires, and cork and leather, produce a poor substitute for an arm or a hand. In the example which we have selected, I mean a lobster's shell compared with a coat of mail, these difficulties stand less in the way than in almost any other that can be assigned; and the consequence is, as we have seen, that art gladly borrows from Nature her contrivance, and imitates it closely.

But to return to insects. I think it is in this class of animals above all others, especially when we take in the multitude of species which the microscope discovers, that we are struck with what Cicero has called "the *insatiable* variety of Nature." There are said to be six thousand species of flies: seven hundred and sixty butterflies; each different from all the rest, (St. Pierre.)[70] The same writer tells us, from his own observation, that thirty-seven species of winged insects with distinctions well expressed, visited a single strawberry-plant in the course of three weeks.* Ray observed, within the compass of a mile or two of his own house, two hundred kinds of butterflies,[71] nocturnal and diurnal. He likewise asserts, but, I think, without any grounds of exact computation, that the number of species of insects, reckoning all sorts of them, may not be short of ten thousand.† And in this vast variety of aniimal forms, (for the observation is not confined to insects, though more applicable perhaps to them than to any other class,) we are sometimes led to take notice of the different methods, or rather of the studiously diversified methods, by which one and the same purpose is attained. In the article of breathing, for example, which was to be provided for in some way or other, besides the ordinary varieties of lungs, gills, and breathing-holes, (for insects in general respire, not by the mouth, but through holes in the sides,) the nymphæ of gnats have an apparatus to raise their *backs* to the top of the water, and so take breath. The hydrocanthari do the like by thrusting their *tails* out of the water.* The maggot of the eruca labra has a long tail, one part sheathed within another, (but which it can draw out at pleasure,) with a starry tuft at the end, by which *tuft*, when expanded upon the surface, the insect both supports itself in the water, and draws in the air which is necessary. In the article of natural clothing, we have the skins of animals invested with scales, hair, feathers, mucus, froth, or itself turned into a shell or crust. In the no less necessary article of offence and defence, we have teeth, talons, beaks, horns, stings, prickles, with (the most singular expedient for the same purpose) the power of giving the electric shock, and, as is credibly related of some animals, of driving away their pursuers by an intolerable fœtor, or of blackening the water through which they are pursued. The consideration of these appearances might induce us to believe that *variety* itself, distinct from every other reason, was a motive in the mind of the Creator, or with the agents of his will.

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[70] There are collections of insects in this country [England] which, in all probability, contain forty thousand species. The number of species in existence may fairly be reckoned at sixty or eighty thousand. Mr. Stephens, in his catalogue of British insects, enumerates ten thousand, since the publication of which, many new species have been discovered. We are now speaking of true insects,—animals having six legs, &c.,—and not including crabs, spiders, scorpions, and others, which *have been* classed with insects.—Eng. Ed.

[71] Ray must mean butterflies and *moths*,—we have not one hundred species of butterflies in this country; and besides, no butterflies are "nocturnal."—Eng. Ed.

* Vol. i. p. 3.

† Wisd. of God, p. 23.

To this great variety in organized life, the Deity has given, or perhaps there arises out of it, a corresponding variety of animal *appetites*. For the final cause of this we have not far to seek. Did all animals covet the same element, retreat, or food, it is evident how much fewer could be supplied and accommodated, than what at present live conveniently together, and find a plentiful subsistence. What one nature rejects, another delights in. Food which is nauseous to one tribe of animals, becomes, by that very property which makes it nauseous, an alluring dainty to another tribe. Carrion is a treat to dogs, ravens, vultures, fish.[72] The exhalations of corrupted substances attract flies by crowds. Maggots revel in putrefaction.[73]

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* Derham, p. 7.

CHAPTER XX.

OF PLANTS.

I THINK a designed and studied mechanism, to be in general more evident in animals than in *plants;* and it is unnecessary to dwell upon a weaker argument, where a

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[72] Very many insects subsist entirely upon carrion, both in the larva and imago state, and in hot weather must be highly serviceable in removing such noxious substances. In this point of view, the maggots of flies are exceedingly useful; a carcass becoming speedily threaded in every direction by them, is soon either devoured or wasted.—ENG. ED.

[73] The most remarkable circumstance relative to instinct, as well as to the habits of insects, the architecture of the bee, has been observed upon in a former note. The manufacture of the wasp perhaps comes next, and is to the chemistry, what the former is to the mathematics, of instinct. It furnishes, too, one of the most striking instances of the discoveries of man having been anticipated by the lower animals; and is another remarkable proof how many more might have been made, by closely attending to their habits;—perhaps a more remarkable proof than those referred to in the text of this chapter, and hinted at in chapter viii., where the author is treating of the vertebræ and ribs. It is certain, that some of the most material improvements in paper-making, recently introduced, as the use of other substances besides rags, and the obtaining toughness by means of long fibres, had been known to the wasp from its first creation. Its whole process in making what is called *wasp-paper*, is precisely that of the best paper-makers. It is only mentioned here, as another among the striking instances of the Divine agency, through the operations of unreasoning animals—instances which fill the contemplative mind with the most profound and pleasing admiration, and dispose it to the enjoyment and the duty of heartfelt devotion.

The migration of birds is another subject full of instruction, regarding the great questions connected with instinct. Observation seems at variance with the notion of the older birds teaching the yearlings; indeed, the two classes have been found not to travel together. But the agitation universally observed in birds of passage kept in cages, at the stronger is at hand. There are, however, a few observations upon the vegetable kingdom, which lie so directly in our way, that it would be improper to pass by them without notice.

The one great intention of Nature in the structure of plants, seems to be the perfecting of the *seed*, and, what is part of the same intention, the preserving of it until it be *perfected*. This intention shows itself, in the first place, by the care which appears to be taken, to protect and ripen, by every advantage which can be given to them of situation in the plant, those parts which most immediately contribute to fructification, viz., the antheræ, the stamina, and the stigmata. These parts are usually lodged in the centre, the recesses, or the labyrinths of the flower—during their tender and immature state are shut up in the stalk, or sheltered in the bud—as soon as they have acquired firmness of texture sufficient to bear exposure, and are ready to perform the important office which is assigned to them, they are disclosed to the light and air, by the bursting of the stem or the expansion of the petals; after which they have, in many cases, by the very form of the flower during its blow, the light and warmth reflected upon them from the concave side of the cup. What is called also the *sleep* of plants is the leaves or petals disposing themselves in such a manner as to shelter the young stems, buds, or fruit. They turn up, or they fall down, according as this purpose renders either change of position requisite. In the growth of corn, whenever the plant begins to shoot, the two upper leaves of the stalk join together, embrace the ear, and protect it till the pulp has acquired a certain degree of consistency. In some water-plants, the flowering and fecundation are carried on *within* the stem, which afterwards opens to let loose the impregnated seed.* The *pea*, or papilionaceous

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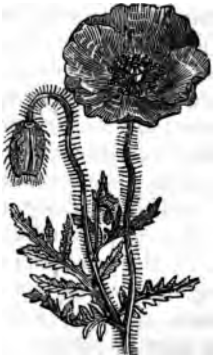
season of migration, proves clearly that no experience nor instruction will account for the change of place. See Mr. W. Herbert's excellent remarks on this instinct, and on the similar instincts respecting choice of food, which makes birds bred in a cage, at once select their appointed food, when shown them for the first time. White's 'Selbourne,' edit. 1833, p. 41, *et seq.*—Eng. Ed.

* Philos. Transact. part ii. 1796, p. 502.

tribe, enclose the parts of fructification within a beautiful folding of the internal blossom, sometimes called, from its shape, the boat or keel—itself also protected under a penthouse, formed by the external petals. This structure is very artificial ; and what adds to the value of it, though it may diminish the curiosity, very general. It has also this further advantage, (and it is an advantage strictly mechanical,) that all the blossoms turn their *backs* to the wind, whenever the gale blows strong enough to endanger the delicate parts, upon which the seed depends. I have observed this a hundred times in a field of peas in blossom. It is an aptitude which results from the figure of the flower, and, as we have said, is strictly mechanical, as much so as the turning of a weather-board or tin cap, upon the top of a chimney. Of the *poppy*, and of many similar species of flowers, the head while it is growing hangs down; a rigid curvature in the upper part of the stem giving to it that position: and in that position it is impenetrable by rain or moisture. When the head has acquired its size, and is ready to open, the stalk *erects* itself for the purpose, as it should seem, of presenting the flower, and with the flower the instruments of fructification, to the genial influence of the sun's rays. This always struck me as a curious property, and specifically as well as



[*Papaver rhœas*—Poppy.]

originally provided for, in the constitution of the plant; for if the stem be only bent by the weight of the head, how comes it to straighten itself when the head is the heaviest? These instances show the attention of Nature to this principal object, the safety and maturation of the parts upon which the seed depends.

In *trees*, especially in those which are natives of colder climates, this point is taken up earlier. Many of these trees (observe in particular the *ash* and the *horse-chestnut*) produce the embryos of the leaves and flowers in one year, and bring them to perfection the following. There is a winter therefore to be gotten over. Now what we are to remark is, how Nature has prepared for the trials and severities of that season. These tender embryos are, in the first place, wrapped up with a compactness which no art can imitate; in which state they compose what we call the bud. This is not all. The bud itself is enclosed in scales; which scales are formed from the remains of past leaves, and the rudiments of future ones.[74] Neither is this the whole. In the coldest climates, a third preservative is added, by the bud having a *coat* of gum or resin, which, being congealed, resists the strongest frosts. On the approach of warm weather, this gum is softened, and ceases to be a hindrance to the expansion of the leaves and flowers. All this care is part of that system of provisions, which has for its object and consummation the production and perfecting of the seeds.

The SEEDS themselves are packed up in a *capsule*, a vessel composed of coats, which, compared with the rest of the flower, are strong and tough. From this vessel projects a tube, through which tube the farina, or some subtile fecundating effluvium that issues from it, is admitted to the seed. And here also occurs a mechanical variety, accommodated to the different circumstances under which the same purpose is to be accomplished. In flowers which are erect, the pistil is shorter than the stamina; and the pollen, shed from the antheræ into the cup of the flower, is caught in its descent by the head of the pistil, called the stigma. But how is this managed when the flowers hang down, (as does the crown-imperial for instance,) and in which position, the farina, in its fall, would be carried from the stigma, and not towards it? The relative length of the parts is now inverted. The pistil in these flowers is usually longer, instead of shorter, than the stamina, that its protruding summit may receive the pollen as it drops to the ground. In some cases, (as in the *nigella*,) where the shafts of the pistils or styles are disproportionably long, they bend down their extremities upon the antheræ, that the necessary approximation may be effected.

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[74] This is not exactly true. Buds are not enclosed in scales formed from the remains of past leaves, except in a few rare instances, to which it cannot be supposed that the author refers; neither are they protected by what can correctly be called the rudiments of future leaves, or are only protected in part. The extensive scales of a bud, those in which the office of protection more especially resides, are rudimentary leaves, which are formed at the end of the season, when the force of developement in the vegetable system is weak and imperfect; they do not become leaves another season, but are simply thrown off by the expansion of the leaves which unfold from within them.—ENG. ED.

But, (to pursue this great work in its progress,) the impregnation, to which all this machinery relates, being completed, the other parts of the flower fade and drop off, whilst the *gravid seed-vessel*, on the contrary, proceeds to increase its bulk, always to a great, and, in some species, (in the gourd, for example, and melon,) to a surprising comparative size; assuming in different plants an incalculable variety of forms, but all evidently conducing to the security of the seed. By virtue of this process, so necessary, but so diversified, we have the seed, at length, in stone-fruits and nuts, incased in a strong shell, the shell itself enclosed in a pulp or husk, by which the seed within is, or hath been, fed; or more generally, (as in grapes, oranges, and the numerous kinds of berries,) plunged overhead in a glutinous syrup, contained within a skin or bladder: at other times (as in apples and pears) imbedded in the heart of a firm, fleshy substance; or (as in strawberries) pricked into the surface of a soft pulp.

These and many more varieties exist in what we call *fruits.** In pulse, and grain, and grasses; in trees, and shrubs, and flowers; the variety of the seed-vessels is incomputable. We have the seeds (as in the pea tribe) regularly disposed in parchment pods, which, though soft and membranous, completely exclude the wet even in the heaviest rains; the pod also, not seldom (as in the bean) lined with a fine down; at other times (as in the senna) distended like a blown bladder; or we have the seed enveloped in wool, (as in the cotton-plant,) lodged (as in pines) between the hard and compact scales of a cone, or barricadoed (as in the artichoke and thistle) with spikes and prickles; in mushrooms, placed under a penthouse; in ferns, within slits in the back part of the leaf: or (which is the most general organization of all) we find them covered by strong, close tunicles, and attached to the stem according to an order appropriated to each plant, as is seen in the several kinds of grains and of grasses.

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* From the conformation of fruits alone, one might be led, even without experience, to suppose, that part of this provision was destined for the utilities of ani-

In which enumeration, what we have first to notice is, unity of purpose under variety of expedients. Nothing can be more *single* than the design; more *diversified* than the means. Pellicles, shells, pulps, pods, husks, skin, scales armed with thorns, are all employed in prosecuting the same intention. Secondly; we may observe, that, in all these cases, the purpose is fulfilled within a just and *limited* degree. We can perceive, that if the seeds

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mals. As limited to the plant, the provision itself seems to go beyond its object. The flesh of an apple, the pulp of an orange, the meat of a plum, the fatness of the olive, appear to be *more* than sufficient for the nourishing of the seed or kernel. The event shows that this redundancy, if it be one, ministers to the support and gratification of animal natures; and when we observe a provision to be more than sufficient for one purpose, yet wanted for another purpose, it is not unfair to conclude, that both purposes were contemplated together. It favors this view of the subject to remark, that fruits are not (which they might have been) ready all together, but that they ripen in succession throughout a great part of the year; some in summer; some in autumn; that some require the slow maturation of the winter, and supply the spring; also, that the coldest fruits grow in the hottest places. Cucumbers, pineapples, melons, are the natural produce of warm climates, and contribute greatly, by their coolness, to the refreshment of the inhabitants of those countries.

I will add to this note the following observation, communicated to me by Mr. Brinkley.

"The eatable part of the cherry or peach first serves the purposes of perfecting the seed or kernel, by means of vessels passing through the stone, and which are very visible in a peach-stone. After the kernel is perfected, the stone becomes hard, and the vessels cease their functions. But the substance surrounding the stone, is not then thrown away as useless. That which was before only an instrument for perfecting the kernel, now receives and retains to itself the whole of the sun's influence, and thereby becomes a grateful food to man. Also, what an evident mark of design is the stone protecting the kernel! The intervention of the stone prevents the second use from interfering with the first."—*Note of the Author.*

of plants were more strongly guarded than they are, their greater security would interfere with other uses. Many species of animals would suffer, and many perish, if they could not obtain access to them. The plant would overrun the soil; or the seed be wasted for want of room to sow itself. It is sometimes as necessary to destroy particular species of plants, as it is, at other times, to encourage their growth. Here, as in many cases, a balance is to be maintained between opposite uses. The provisions for the preservation of seeds appear to be directed chiefly against the inconstancy of the elements, or the sweeping destruction of inclement seasons. The depredations of animals, and the injuries of accidental violence, are allowed for in the abundance of the increase. The result is, that out of the many thousand different plants which cover the earth, not a single species, perhaps, has been lost since the creation.

When Nature has perfected her seeds, her next care is to disperse them. The seed cannot answer its purpose, while it remains confined in the capsule. After the seeds therefore are ripened, the pericarpium opens to let them out; and the opening is not like an accidental bursting, but, for the most part, is according to a certain rule in each plant. What I have always thought very extraordinary, nuts and shells, which we can hardly crack with our teeth, divide and make way for the little tender sprout which proceeds from the kernel. Handling the nut, I could hardly conceive how the plantule was ever to get out of it. There are cases, it is said, in which the seed-vessel, by an elastic jerk, at the moment of its explosion, casts the seeds to a distance. We all, however, know, that many seeds (those of most composite flowers, as of the thistle, dandelion, &c.) are endowed with what are not improperly called *wings*; that is, downy appendages, by which they are enabled to float in the air, and are carried oftentimes by the wind, to great distances from the plant which produces them. It is the swelling also of this downy tuft within the seed-vessel, that seems to overcome the resistance of its coats, and to open a passage for the seed to escape.

But the *constitution* of seeds, is still more admirable than either their preservation or their dispersion. In the body of the seed of every species of plant, or nearly of every one, provision is made for two grand purposes: first, for the safety of the *germ*; secondly, for the temporary support of the future plant. The sprout, as folded up in the seed, is delicate and brittle beyond any other substance. It cannot be touched without being broken. Yet, in beans, peas, grass-seeds, grain, fruits, it is so fenced on all sides, so shut up and protected, that, whilst the seed itself is rudely handled, tossed into sacks, shovelled into heaps, the sacred particle, the miniature plant, remains unhurt. It is wonderful how long many kinds of seeds, by the help of their integuments, and perhaps of their oils, stand out against decay. A grain of mustard-seed has been known to lie in the earth for a hundred years; and, as soon as it had acquired a favorable situation, to shoot as vigorously as if just gathered from the plant. Then as to the second point, the temporary support of the future plant, the matter stands thus. In grain, and pulse, and kernels, and pippins, the germ composes a very small part of the seed. The rest consists of a nutritious substance, from which the sprout draws its aliment for some considerable time after it is put forth; viz., until the fibres, shut out from the other end of the seed, are able to imbibe juices from the earth, in a sufficient quantity for its demand. It is owing to this constitution, that we see seeds sprout, and the sprouts make a considerable progress, without any earth at all. It is an economy, also, in which we remark a close analogy between the seeds of plants and the eggs of animals. The same point is provided for, in the same manner, in both. In the egg, the residence of the living principle, the cicatrix, forms a very minute part of the contents. The white, and the white only, is expended in the formation of the chicken. The yolk, very little altered or diminished, is wrapped up in the abdomen of the young bird, when it quits the shell; and serves for its nourishment, till it have learnt to pick its own food. This perfectly resembles the first nutrition of a plant. In the plant, as well as in the animal, the structure has every character of contrivance belonging to it: in both it breaks the transition from prepared to unprepared aliment; in both, it is prospective and compensatory. In animals which suck, this intermediate nourishment is supplied by a different source.

In all subjects, the most common observations are the best, when it is their truth and strength which have made them common. There are, of this sort, *two* concerning plants, which it falls within our plan to notice. The *first* relates to what has already been touched upon, their germination. When a grain of corn is cast into the ground, this is the change which takes place. From one end of the grain issues a green sprout; from the other, a number of white fibrous threads. How can this be explained? Why not sprouts from both ends? why not fibrous threads from both ends? To what is the difference to be referred, but to design; to the different uses which the parts are thereafter to serve; uses which discover themselves in the sequel of the process? The sprout, or plumule, struggles into the air; and becomes the plant, of which, from the first, it contained the rudiments: the fibres shoot into the earth; and thereby both fix the plant to the ground, and collect nourishment from the soil for its support. Now, what is not a little remarkable, the parts issuing from the seed take their respective directions, into whatever position the seed itself happens to be cast. If the seed be thrown into the wrongest possible position; that is, if the ends point in the ground the reverse of what they ought to do, every thing, nevertheless, goes on right. The sprout, after being pushed down a little way, makes a bend, and turns upwards; the fibres, on the contrary, after shooting at first upwards, turn down. Of this extraordinary vegetable fact, an account has lately been attempted to be given. "The plumule (it is said) is stimulated by the *air* into action, and elongates itself when it is thus most excited; the radicle is stimulated by *moisture*, and elongates itself when *it* is thus most excited. Whence one of these grows upward in quest of its adapted object, and the other downward."* Were this account better verified by experiment than it is, it only shifts the contrivance. It does not disprove the contrivance; it only removes it a little further back. Who, to use our author's own language, "*adapted* the objects?" Who gave such a quality to these connate parts, as to be susceptible of *different* "stimulation;" as to be "excited" each only by its own element, and precisely by that which the success of the vegetation requires? I say, "which the success of the vegetation requires:" for the toil of the husbandman would have been in vain, his laborious and expensive preparation of the ground in vain; if the event must, after all, depend upon the position in which the scattered seed was sown. Not one seed out of a hundred would fall in a right direction.

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* Darwin's Phytologia, p. 144.

Our *second* observation is upon a general property of climbing plants, which is strictly mechanical. In these plants, from each knot or joint, or, as botanists call it, axilla, of the plant, issue, close to each other, two shoots, one bearing the flower and fruit, the other drawn out into a wire, a long, tapering, spiral tendril, that twists itself round any thing which lies within its reach. Considering that in this class two purposes are to be provided for, (and together,) fructification and support, the fruitage of the plant and the sustentation of the stalk, what means could be used more effectual, or, as I have said, more mechanical, than what this structure presents to our eyes? Why, or how, without a view to this double purpose, do two shoots, of such different and appropriate forms, spring from the same joint, from contiguous points of the same stalk? It never happens thus in robust plants, or in trees. "We see not," says Ray, "so much as one tree, or shrub, or herb, that hath a firm and strong stem, and that is able to mount up and stand alone without assistance, *furnished with these tendrils.*" Make only so simple a comparison as that between a pea and a bean. Why does the pea put forth tendrils, the bean not, but because the stalk of the pea cannot support itself, the stalk of the bean can? We may add also, as a circumstance not to be overlooked, that, in the pea tribe, these clasps do not make their appearance till they are wanted, till the plant has grown to a height to stand in need of support.

This word "support" suggests to us a reflection upon a property of grasses, of corn, and canes. The hollow stems of these classes of plants are set at certain intervals with joints. These joints are not found in the trunks of trees, or in the solid stalks of plants. There may be other uses of these joints; but the fact is, and it appears to be at least one purpose designed by them, that they *corroborate* the stem, which, by its length and hollowness, would otherwise be too liable to break or bend.

Grasses are Nature's care. With these she clothes the earth—with these she sustains its inhabitants. Cattle feed upon their leaves; birds upon their smaller seeds—men upon the larger; for few readers need be told, that the plants which produce our bread-corn belong to this class. In those tribes which are more generally considered as grasses, their extraordinary means and powers of preservation and increase, their hardiness, their almost unconquerable disposition to spread, their faculties of reviviscence, coincide with the intention of Nature concerning them. They thrive under a treatment by which other plants are destroyed. The more their leaves are consumed, the more their roots increase. The more they are trampled upon, the thicker they grow. Many of the seemingly dry and dead leaves of grasses revive, and renew their verdure in the spring.[75] In lofty mountains, where the summer heats are not sufficient to ripen the seeds, grasses abound which are viviparous, and consequently able to propagate themselves without seed. It is an observation likewise which has often been made, that herbivorous animals attach themselves to the leaves of grasses, and if at liberty in their pastures to range and choose, leave untouched the straws which support the flowers.*

The GENERAL properties of vegetable nature, or properties common to large portions of that kingdom, are almost all which the compass of our argument allows us to bring forward. It is impossible to follow plants into their several species. We may be allowed, however, to single out three or four of these species as worthy of a particular notice, either by some singular mechanism, or by some peculiar provision, or by both.

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[75] Here, to be correct, we should read, "Many grasses whose leaves are so dry and withered that the plants appear dead, revive and renew their existence in the spring, by pushing forth new leaves from the bosom of the former ones."—ENG. ED.

* Withering, Bot. Arr. vol. i. p. 28, ed. 2d.

I. In Dr. Darwin's 'Botanic Garden,'(l. 395, note,)is the following account of the *vallisneria*, as it has been observed in the river Rhone:—" They have roots at the bottom of the Rhone. The flowers of the *female plant* float on the surface of the water, and are furnished with an *elastic spiral stalk*, which extends or contracts as the water rises or falls; this rise or fall, from the torrents which flow into the river, often amounting to many feet in a few hours. The flowers of the *male plant* are produced under water; and as soon as the fecundating farina is mature, they separate themselves from the plant, rise to the surface, and are wafted by the air, or borne by the currents, to the female flowers." Our attention in this narrative will be directed to two particulars: first, to the mechanism, the "elastic spiral stalk," which lengthens or contracts itself according as the water rises or falls; secondly, to the provision which is made for bringing the male flower, which is produced *under* water, to the female flower, which floats upon the surface.

II. My second example I take from Withering's 'Arrangement,' vol. ii. p. 209, ed. 3. " The *cuscuta europæa* is a parasitical plant. The seed opens, and puts forth a *little spiral body*, which does *not* seek the earth to take root, but *climbs* in a spiral direction, from right to left, up other plants, from which, by means of vessels, it draws its nourishment." The " little spiral body " proceeding from the seed is to be compared with the fibres which seed send out in ordinary cases; and the comparison ought to regard both the form of the threads and the direction. They are straight; this is spiral. They shoot downwards; this points upwards. In the rule and in the exception we equally perceive design.[76]

[76] This statement is incorrect. When the seed of cuscuta opens, it puts forth a little thread-shaped body, namely, a young root, which,

III. A better known parasitical plant is the evergreen shrub, called the *misseltoe*. What we have to remark in it, is a singular instance of *compensation*. No art hath yet made these plants take root in the earth. Here, therefore, might seem to be a mortal defect in their constitution. Let us examine how this defect is made up to them. The seeds are endued with an adhesive quality so tenacious, that, if they be rubbed upon the smooth bark of almost any tree, they will stick to it. And then

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as in other plants, plunges into the earth, and from the opposite end elevates a young and slender stem. The latter, after a little while, applies itself to some neighboring plant, and emits very short broad suckers on the side of its stem, which is placed in contact with the other plant; by these suckers it fastens itself upon the new branch, round which it twines, and as soon as it is secure in its new station, its root perishes, and it ceases to have any communication with the earth. This property in the cuscuta, seems to be given it in consequence of its root not having the power that such parts usually possess, of branching, lengthening, and attracting nutriment from the earth. If the cuscuta seed germinates at a distance from any living branch to which it can adhere, it elevates its stem for a short time in the air and then dies. If it is so placed as to be able to come in contact only with dead branches, still it dies; and it is only when it succeeds in fixing itself upon a living branch, that it emits its suckers and continues to exist. Once attached to the living stem of another plant, it takes that for its base, and turning round once or twice, then darts forth in a straight line, touches something else, which it also fixes in its folds, and thus travels from plant to plant, sometimes covering a very considerable extent of bushes.—ENG. ED what follows? Roots, springing from these seeds, insinuate their fibres into the woody substance of the tree; and the event is, that a misseltoe plant is produced next winter.* Of no other plant do the roots refuse to shoot in the ground; of no other plant do the seeds possess this adhesive, generative quality, when applied to the bark of trees.[77]

IV. Another instance of the *compensatory* system is in the autumnal crocus, or meadow saffron, (*colchicum autumnale.*) I have pitied this poor plant a thousand times. Its blossom rises out of the ground in the most forlorn condition possible; without a sheath, a fence, a calyx, or even a leaf to protect it: and that, not in the spring, not to be visited by summer suns, but under all the disadvantages of the declining year. When we come, however, to look more closely into the structure of this plant, we find that, instead of its being neglected, Nature has gone out of her course to provide for its security, and to make up to it for all its defects. The seed-vessel, which in other plants is situated within the cup of the

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[77] These statements are true, not only of the misseltoe or *viscum actum*, but of the whole natural order *Loranthaceæ*, with one exception. —ENG. ED.

* Withering, Bot. Arr. vol. i. p. 203, ed. 2d.

flower, or just beneath it, in this plant lies buried ten or twelve inches under ground, within the bulbous root. The tube of the flower, which is seldom more than a few tenths of an inch long, in this plant extends down to the root. The styles in all cases reach the seed-vessel; but it is in this by an elongation unknown to any other plant. All these singularities contribute to one end. "As this plant blossoms late in the year, and probably would not have time to ripen its seeds before the access of winter, which would destroy them, Providence has contrived its structure such, that this important office may be performed at a depth in the earth out of reach of the usual effects of frost."* That is to say, in the autumn, nothing is done above ground but the business of impregnation; which is an affair between the antheræ and the stigmata, and is probably soon over. The maturation of the impregnated seed, which in other plants proceeds within a capsule, exposed together with the rest of the flower to the open air, is here carried on, and during the whole winter, within the heart, as we may say, of the earth, that is, "out of the reach of the usual effects of frost." But then a new difficulty presents itself. Seeds, though perfected, are known not to vegetate at this depth in the earth. Our seeds, therefore, though so safely lodged, would, after all, be lost to the purpose for which all seeds are intended. Lest this should be the case, "a second admirable provision is made to raise them above the surface when they are perfected, and to sow them at a proper distance:" viz., the germ grows up *in the spring*, upon a fruit-stalk, accompanied with leaves. The seeds now, in common with those of other plants, have the benefit of the summer, and are sown upon the surface. The order of vegetation externally, is this:—the plant produces its flowers in September; its leaves and fruits in the spring following.

V. I give the account of the *dionæa muscipula*, an extraordinary American plant, as some late authors have related it: but whether we be yet enough acquainted with the plant, to bring every part of this account to the test of repeated and familiar observation, I am unable to say. "Its leaves are jointed, and furnished with two rows of strong prickles; their surfaces covered with a number of minute glands, which secrete a sweet liquor that allures the approach of flies. When these parts are touched by the legs of flies, the two lobes of the leaf instantly spring up, the rows of prickles lock themselves fast together, and squeeze the unwary animal to death."* Here, under a new model, we recognise the ancient plan of Nature, viz., the relation of parts and provisions to one another, to a common office, and to the utility of the organized body to which they belong. The attracting syrup,[78] the rows of strong prickles, their position so as to interlock the joints of the leaves; and, what is more than the rest, that singular irritability of their surfaces, by which they close at a touch; all bear a contributory part in producing an effect, connected either with the defence or with the nutrition of the plant.[79]

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* Withering, ubi supra, p. 360.

CHAPTER XXI.

THE ELEMENTS.

WHEN we come to the elements, we take leave of our mechanics; because we come to those things, of the organization of which, if they be organized, we are confessedly ignorant. This ignorance is implied by their name. To say the truth, our investigations are stopped, long before we arrive at this point. But then, it is for our comfort to find, that a knowledge of the constitution of the elements is not necessary for us. For instance, as Addison has well observed, "we know *water* sufficiently, when we know how to boil, how to freeze, how to evaporate, how to make it fresh, how to make it run or

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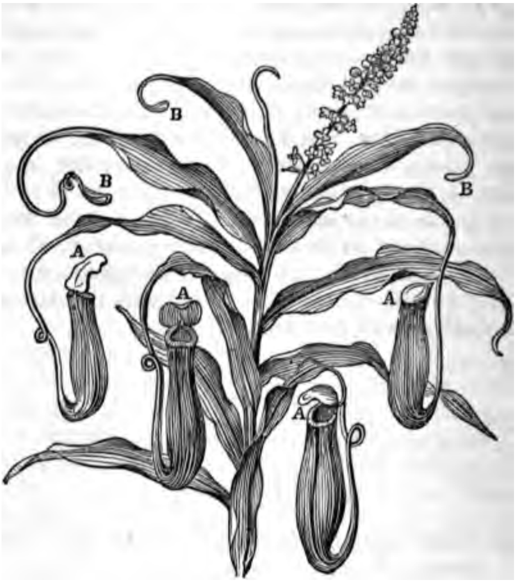
[78] From this account must be omitted, what is said of the syrup that allures the approach of flies. There is no such attraction upon the leaves of the dionæa.—ENG. ED.

[79] The pitcher-plant, *nepenthes distillatoria*, of the East, is another example which may be given. It produces natural pitchers or tankards, holding from a pint to a quart of pure water. Even when raised in

* Smellie's Phil. of Nat. Hist. vol. i. p. 5.

this country under glass, they have been known to hold half a pint. The plate represents these, with their lids A, A, which move on hinges,



opening in moist weather, and shutting quite close in dry, to prevent evaporation. When the pitcher becomes full, and requires additional support, the hook A behind the lid seizes on some neighboring tendril, and holds by it. B, B, are young pitchers just unfolding. This water which supplies the pitchers, is secreted by the process of vegetation, and is perfectly pure, though the plant grows in a muddy and unwholesome marsh.

The *palo de vaca*, or cow-tree of South America, yields a delicious and nutritive milk on its trunk being pierced ; and it grows in the most parched soil, and in a climate where rain is unknown during half the year.

The supply of fine water afforded by the *tillandsia*, or water-with, in Jamaica, and by the bejuco, or *cissus latifolia*, in the East, on cutting, is a fact of the same class. The latter plant also twines round other trees, and affords, as it were, a reservoir for their use — ENG. ED.

spout out, in what quantity and direction we please, without knowing what water is." The observation of this excellent writer has more propriety in it now, than it had at the time it was made ; for the constitution and the constituent parts of water appear in some measure to have been lately discovered ; yet it does not, I think, appear, that we can make any better or greater use of water, since the discovery than we did before it.

We can never think of the elements, without reflecting upon the number of distinct uses which are *consolidated* in the same substance. The *air* supplies the lungs, supports fire, conveys sound, reflects light, diffuses smells, gives rain, wafts ships, bears up birds. *'Εξ ὕδατος τα παντα* :* *water*, besides maintaining its own inhabitants, is the universal nourisher of plants, and through them of terrestrial animals ; is the basis of their juices and fluids ; dilutes their food ; quenches their thirst ; floats their burdens. ***Fire*** warms, dissolves, enlightens ; is the great promoter of vegetation and life, if not necessary to the support of both.

We might enlarge, to almost any length we please, upon each of these uses ; but it appears to me almost sufficient to state them. The few remarks, which I judge it necessary to add, are as follow :—

I. Air is essentially different from earth. There appears to be no necessity for an atmosphere's investing our globe ; yet it does invest it : and we see how many, how various, and how important are the purposes which it answers, to every order of animated, not to say of organized, beings, which are placed upon the terrestrial surface. I think that every one of these uses will be understood, upon the first mention of them, except it be that of ***reflecting*** light, which may be explained thus :—If I had the power of seeing, only by means of rays coming directly from the sun, whenever I turned my back upon the luminary, I should find myself in darkness. If I had the power of seeing by reflected light, yet by means only of light reflected from solid masses, these masses would shine indeed, and glisten, but it would be in the dark. The hemisphere, the sky, the world, could only be *illuminated*, as it is illuminated, by the light of the sun being from all sides, and in every direction, reflected to the eye, by particles, as numerous, as thickly scattered, and as widely diffused, as are those of the air.

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* [Literally—*From* or *out of water, all things*—All things formed of water ; a saying of some of the ancient philosophers.]

Another general quality of the atmosphere is the power of evaporating fluids. The adjustment of this quality to our use, is seen in its action upon the sea. In the sea, water and salt are mixed together most intimately ; yet the atmosphere raises the water, and leaves the salt. Pure and fresh as drops of rain descend, they are collected from brine. If evaporation be solution, (which seems to be probable,) then the air dissolves the water, and not the salt. Upon whatever it be founded, the distinction is critical : so much so, that when we attempt to imitate the process by art, we must regulate our distillation with great care and nicety, or, together with the water, we get the bitterness, or at least the distastefulness, of the marine substance ; and, after all, it is owing to this original elective power in the air, that we can effect the separation which we wish, by any art or means whatever.

By evaporation, water is carried up into the air ; by the converse of evaporation, it falls down upon the earth. And how does it fall ? Not by the clouds being all at once reconverted into water, and descending like a sheet; not in rushing down in columns from a spout ; but in moderate drops, as from a colander. Our watering-pots are made to imitate showers of rain. Yet, *à priori*, I should have thought either of the two former methods more likely to have taken place than the last.

By respiration, flame, putrefaction, air is rendered unfit for the support of animal life. By the constant operation of these corrupting principles, the whole atmosphere, if there were no restoring causes, would come at length to be deprived of its necessary degree of purity. Some of these causes seem to have been discovered, and their efficacy ascertained by experiment ; and so far as the discovery has proceeded, it opens to us a beautiful and a wonderful economy. *Vegetation* proves to be one of them. A sprig of mint, corked up with a small portion of foul air, placed in the light, renders it again capable of supporting light or flame. Here, therefore, is a constant circulation of benefits maintained between the two great provinces of organized nature. The plant purifies what the animal has poisoned; in return, the contaminated air is more than ordinarily nutritious to the plant.[80] *Agitation with water* turns out to be another of

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[80] The experiments of Priestley, confirmed by those of Ingenhouz and Saussure, led to the conclusion, that the air is kept pure by the action of plants, these emitting more oxygen gas by day than carbonic acid gas by night. Some doubt was thrown upon this point by the experiments of Mr. Ellis; but these appear to have been removed by Sir H. Davy's remarks and experiments. It seems probable that the plant, growing in the light, decomposes both the carbonic acid which exists, though in a very small proportion, in the atmosphere, and also any that may exist in the water applied to its leaves; for Sennebier found, that when these are immersed in water impregnated with carbonic acid, oxygen gas was evolved, but not if water was used which had been boiled.

The process of vegetation appears to be the great means of supplying the loss of oxygen in the atmosphere; indeed, none other have been as yet discovered. The composition of the atmosphere, in respect of purity, though at one time supposed to vary in different places, is now ascertained to be every where invariably the same. It contains about 20 parts of oxygen gas, by measure, in 100, and the remaining 80 are almost entirely nitrogen gas. The only variation is in the slight portion of carbonic acid gas, which never exceeds 1 in 100, and is seldom more than 1 in 1000, supposing the circulation of the air to be unconfined. But the proportion of oxygen to the whole bulk, has been found to be the same at nearly 22,000 feet high, and in the deepest valleys; the same in countries widely remote from each other, and differing in climate as well as soil; the same in the most pestilential marshes, or in hospitals, and in the most open and healthy situations. The agitation of the air by winds speedily mixes all its strata, and prevents the effects of breathing and burning from being perceived. Yet a constant consumption of oxygen is going on, wherever there are either living creatures of the hot-blooded class, or fires of any kind, natural or artificial; and this is so balanced by the process of vegetation, that the uniformity of the air's composition is maintained universally.

The union in which the oxygenous and nitrogenous portions of the atmosphere exist, also merits attention. It is ascertained to be of a peculiar kind; for it is not merely that of mechanical admixture,—the union of aggregation,—inasmuch as the nitrogen gas, being about a seventh part lighter than the oxygen, would rise to the top, and so make the air of higher elevations more pure, contrary to the fact. Nor is it like most other chemical unions, inasmuch as it is both extremely feeble, and is formed without any diminution in the bulk of these restoratives. The foulest air, shaken in a bottle with water for a sufficient length of time, recovers a great degree of its purity.[81] Here then, again, allowing for the scale upon which Nature works, we see the salutary effects of *storms* and *tempests*. The yesty waves which confound the heaven and the sea, are doing the very thing which was done in the bottle. Nothing can be of greater importance to the living creation, than the salubrity of their atmosphere. It ought to reconcile us, therefore, to these agitations of the elements, of which we sometimes deplore the consequences, to know that they tend powerfully to restore to the air that purity which so many causes are constantly impairing.

II. In Water, what ought not a little to be admired, are those negative qualities which constitute its *purity*. Had it been vinous, or oleaginous, or acid; had the sea been filled, or the rivers flowed, with wine or milk, fish, constituted as they are, must have died; plants, constituted as they are, would have withered; the lives of animals which feed upon plants must have perished. Its very *insipidity*, which is one of those negative qualities, renders it the best of all menstrua. Having no taste of its own, it becomes the sincere vehicle of every other. Had there been a taste in water, be it what it might, it would have infected every thing we ate or drank, with an importunate repetition of the same flavor.

Another thing in this element, not less to be admired,

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the two substances combined together. But the kind of union in which the two gases are held is productive of the most beneficial effects. Their disengagement from each other is so easily accomplished, that there is the greatest facility in supporting flame and respiration; while their mixture is so perfect, that the mischiefs are prevented which would arise from their being exhibited either to the lungs or to heated bodies in their pure state.—ENG. ED.

[81] That agitation with water will remove certain impurities in the air is undeniable, but not all impurities. Animals by breathing consume the oxygen, leaving carbonic acid gas and nitrogen gas. Water absorbs the former easily, and bulk for bulk; but of the latter it will only absorb one and a half per cent. So of the products of putrefaction, (besides carbonic acid,) carburetted hydrogen, and sulphuretted hydrogen gases, water will absorb of the latter bulk for bulk; but not above one and two thirds per cent. of the former.—ENG. ED.

is the constant *round* which it travels; and by which, without suffering either adulteration or waste, it is continually offering itself to the wants of the habitable globe. From the sea are exhaled those vapors which form the clouds: these clouds descend in showers, which, penetrating into the crevices of the hills, supply springs; which springs flow in little streams into the valleys; and there uniting, become rivers; which rivers, in return, feed the ocean. So there is an incessant circulation of the same fluid; and not one drop probably, more or less, now than there was at the creation. A particle of water takes its departure from the surface of the sea, in order to fulfil certain important offices to the earth; and having executed the service which was assigned to it, returns to the bosom which it left.

Some have thought, that we have too much water upon the globe, the sea occupying above three-quarters of its whole surface. But the expanse of ocean, immense as it is, may be no more than sufficient to fertilize the earth. Or, independently of this reason, I know not why the sea may not have as good a right to its place as the land. It may proportionably support as many inhabitants; minister to as large an aggregate of enjoyment. The land only affords a habitable surface; the sea is habitable to a great depth.

III. Of Fire, we have said that it *dissolves*. The only idea probably which this term raised in the reader's mind, was that of fire melting metals, resins, and some other substances, fluxing ores, running glass, and assisting us in many of our operations, chemical or culinary. Now these are only uses of an occasional kind, and give us a very imperfect notion of what fire does for us. The grand importance of this dissolving power, the great office indeed of fire in the economy of Nature, is keeping things in a state of solution—that is to say, in a state of fluidity. Were it not for the presence of heat, or of a certain degree of it, all fluids would be frozen. The ocean itself would be a quarry of ice; universal nature stiff and dead.

We see, therefore, that the elements bear not only a strict relation to the constitution of organized bodies, but a relation to each other. Water could not perform its office to the earth without air; nor exist, as water, without fire.[82]

IV. Of Light, (whether we regard it as of the same substance with fire, or as a different substance,) it is altogether superfluous to expatiate upon the use. No man disputes it. The observations, therefore, which I shall offer, respect that little which we seem to know of its constitution.

Light travels from the sun at the rate of twelve millions of miles in a minute. Urged by such a velocity, with what *force* must its particles drive against (I will not say the eye, the tenderest of animal substances, but) every substance, animate or inanimate, which stands in its way! It might seem to be a force sufficient to shatter to atoms the hardest bodies.

How then is this effect, the consequence of such prodigious velocity, guarded against? By a proportionable *minuteness* of the particles of which light is composed. It is impossible for the human mind to imagine to itself any thing so small as a particle of light. But this extreme exility, though difficult to conceive, it is easy to prove. A drop of tallow, expended in the wick of a farthing candle, shall send forth rays sufficient to fill a hemisphere of a mile diameter; and to fill it so full of these rays, that an aperture not larger than the pupil of an eye, wherever it be placed within the hemisphere, shall be sure to receive some of them. What floods of light are continually poured from the sun, we cannot estimate; but the immensity of the sphere which is filled with particles, even if it reached no further than the orbit of the earth, we can in some sort compute; and we have reason to believe, that, throughout this whole region, the particles of light lie, in latitude at least, near to one another. The spissitude of the sun's rays at the earth is such, that the number which falls upon a burning-glass of an inch diameter, is sufficient, when concentrated, to set wood on fire.

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[82] The conducting powers of different substances, are beautifully adapted to the wants of the animal and vegetable kingdom. Snow is so bad a conductor, that it protects the ground effectually in rigorous climates. It is said, that in Siberia, there have been known to be as many as thirty-eight degrees (Fahrenheit) of difference, between the temperature of the air and that of the ground under the snow; the latter not being cooled much below the freezing point. So, too, the animal which, transported to warmer climates, becomes covered with hair, has in its own cold country a woolly covering, and this conducts heat so slowly as to accumulate that which respiration is continually producing.

The peculiarity which distinguishes water from other fluids in freezing, likewise merits attention. It expands, instead of continuing to contract, when cooled to the freezing point; and this has the useful effect of crumbling earth and even rocks, so as to render them fit for assisting the process of vegetation.—Eng. Ed.

The tenuity and the velocity of particles of light, as ascertained by separate observations, may be said to be proportioned to each other, both surpassing our utmost stretch of comprehension; but proportioned. And it is this proportion alone, which converts a tremendous element into a welcome visiter.

It has been observed to me by a learned friend, as having often struck his mind, that, if light had been made by a common artist, it would have been of one uniform *color:* whereas, by its present composition, we have that variety of colors which is of such infinite use to us for the distinguishing of objects; which adds so much to the beauty of the earth, and augments the stock of our innocent pleasures.

With which may be joined another reflection, viz.—that, considering light as compounded of rays of seven different colors, (of which there can be no doubt, because it can be resolved into these rays by simply passing it through a prism,) the constituent parts must be well mixed and blended together, to produce a fluid so clear and colorless, as a beam of light is, when received from the sun.[83]

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[83] The substitution of the undulatory for the atomic theory of light, would produce no alteration whatever in the author's conclusions; and, so far from diminishing, would rather increase the astonishment which the phenomena of Optics are calculated to excite. The same may be said of the discoveries made partly since Dr. Paley's time, partly immediately before the composition of his work, of the two other kinds of rays which accompany those of light; the *calorific,* or heat-making, which partly mix with the *colorific*, or color-making, of the spectrum, and partly fall beyond the least refrangible rays; and the *chemical*,

CHAPTER XXII.

ASTRONOMY.*

My opinion of Astronomy has always been, that it is *not* the best medium, through which to prove the agency of an intelligent Creator; but that, this being proved, it shows, beyond all other sciences, the magnificence of his operations. The mind which is once convinced, it raises to sublimer views of the Deity than any other subject affords; but it is not so well adapted as some other subjects are, to the purpose of argument. We are destitute of the means of examining the constitution of the heavenly bodies. The very simplicity of their appearance is against them. We see nothing but bright points, luminous circles, or the phases of spheres reflecting the light which falls upon them. Now we deduce design from relation, aptitude, and correspondence of *parts*. Some degree, therefore, of *complexity* is necessary to render a subject fit for this species of argument. But the heavenly bodies do not, except, perhaps, in the instance of Saturn's ring, present themselves to our observation as compounded of parts at all. This, which may be a perfection in them, is a disadvantage to us, as inquirers after their nature. They do not come within our mechanics.

And what we say of their forms, is true of their *motions*. Their motions are carried on without any sensible intermediate apparatus; whereby we are cut off from one

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which affect certain metallic salts, without either producing illumination or exciting heat, and which are to be found among and beyond, the most refrangible rays: So that a beam of white light consists of three kinds of ray, and one of these kinds consists of seven subdivisions; at least according to the Newtonian theory, which divides the colors into seven, instead of innumerable gradations of shades.—Eng. Ed.

* For the articles of this chapter marked with an asterisk, I am indebted to some obliging communications received (through the hands of the Lord Bishop of Elphin) from the Rev. J. Brinkley, M. A., Andrew's Professor of Astronomy in the University of Dublin.—(*Note of the Author.*) [Professor Brinkley was afterwards, as is well known, Bishop of Cloyne. His lordship, upon being made acquainted with the plan of the present publication, kindly communicated the notes now added, and which are marked with his name.—Eng. Ed.]

principal ground of argumentation—analogy. We have nothing wherewith to compare them; no invention, no discovery, no operation or resource of art, which in this respect resembles them. Even those things which are made to imitate and represent them—such as orreries, planetaria, celestial globes, &c., bear no affinity to them, in the cause and principle by which their motions are actuated. I can assign for this difference a reason of utility—*viz.*, a reason why, though the action of *terrestrial* bodies upon each other be, in almost all cases, through the intervention of solid or fluid substances, yet central attraction does not operate in this manner. It was necessary, that the intervals between the planetary orbs should be devoid of any *inert* matter, either fluid or solid, because such an intervening substance would, by its resistance, destroy those very motions, which attraction is employed to preserve. This may be a final cause of the difference; but still the difference destroys the analogy.

Our ignorance, moreover, of the *sensitive* natures, by which other planets are inhabited, necessarily keeps from us the knowledge of numberless utilities, relations, and subserviencies, which we perceive upon our own globe.

After all; the real subject of admiration is, that we understand so much of astronomy as we do. That an animal, confined to the surface of one of the planets; bearing a less proportion to it than the smallest microscopic insect does to the plant it lives upon; that this little, busy, inquisitive creature, by the use of senses which were given to it for its domestic necessities, and by means of the assistance of those senses which it has had the art to procure, should have been enabled to observe the whole system of worlds to which its own belongs; the changes of place of the immense globes which compose it; and with such accuracy as to mark out beforehand, the situation in the heavens in which they will be found, at any future point of time; and that these bodies, after sailing through regions of void and trackless space, should arrive at the place where they were expected, not within a minute, but within a few seconds of a minute, of the time prefixed and predicted: all this is wonderful, whether we refer our admiration to the constancy of the heavenly motions themselves, or to the perspicacity and precision with which they have been noticed by mankind. Nor is this the whole, nor indeed the chief part, of what astronomy teaches. By bringing reason to bear upon observation, (the acutest reasoning upon the exactest observation,) the astronomer has been able, out of the "mystic dance," and the confusion (for such it is) under which the motions of the heavenly bodies present themselves to the eye of a mere gazer upon the skies, to elicit their order and their real paths.

Our knowledge, therefore, of astronomy is admirable, though imperfect; and, amidst the confessed desiderata and desideranda, which impede our investigation of the wisdom of the Deity in these the grandest of his works, there are to be found, in the phenomena, ascertained circumstances and laws, sufficient to indicate an intellectual agency in three of its principal operations, viz., in choosing, in determining, in regulating; in *choosing*, out of a boundless variety of suppositions which were equally possible, that which is beneficial; in *determining*, what, left to itself, had a thousand chances against conveniency, for one in its favor; in *regulating* subjects, as to quantity and degree, which, by their nature, were unlimited with respect to either. It will be our business to offer, under each of these heads, a few instances, such as best admit of a popular explication.

I. Amongst proofs of choice, one is, fixing the source of light and heat in the *centre* of the system. The sun is ignited and luminous, the planets which move round him are cold and dark. There seems to be no antecedent necessity for this order. The sun might have been an opaque mass; some one, or two, or more, or any, or all, the planets, globes of fire. There is nothing in the nature of the heavenly bodies which requires that those which are stationary should be on fire, that those which move should be cold; for, in fact, comets are bodies on fire, or at least capable of the most intense heat, yet revolve round a centre: nor does this order obtain between the primary planets and their secondaries, which are all opaque. When we consider, therefore, that the sun is one ;[84] that the planets going round it, are at least seven ;* that it is indifferent to their nature which are luminous and which are opaque : and also in what order, with respect to each other, these two kinds of bodies are disposed : we may judge of the improbability of the present arrangement taking place by chance.

If, by way of accounting for the state in which we find the solar system, it be alleged, (and this is one amongst the guesses of those who reject an Intelligent Creator,)

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[84] This cut represents a telescopic view of the Sun, showing some of the remarkable spots which have occasionally appeared on its surface, the largest sometimes exceeding the size of the whole Earth. Astronomers, by closely observing the motion which these spots have across the Sun's disc, and the perspective changes which they undergo, in assuming a foreshortened, or oval form, as they approach his edge, previous to their disappearance, have greatly assisted the reasoning, which proves his form to be spherical, and that he has a rotation on his axis. —Eng. Ed.

* [Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and Herschel are here alluded to ; the number has been increased to "at least" eleven by the discovery of Ceres, Pallas, Juno, and Vesta.—Am. Ed.]

that the planets themselves are only cooled or cooling masses, and were once, like the sun, many thousand times hotter than red-hot iron ; then it follows, that the sun also himself must be in his progress towards growing cold; which puts an end to the possibility of his having existed, as he is, from eternity. This consequence arises out of the hypothesis with still more certainty, if we make a part of it, what the philosophers who maintain it have usually taught, that the planets were originally masses of matter, struck off in a state of fusion, from the body of the sun, by the percussion of a comet, or by a shock from some other cause, with which we are not acquainted : for, if these masses, partaking of the nature and substance of the sun's body, have in process of time lost their heat, that body itself, in time, likewise, no matter in how much longer time, must lose its heat also, and therefore be incapable of an eternal duration in the state in which we see it, either for the time to come, or the time past.

The preference of the present to any other mode of distributing luminous and opaque bodies, I take to be evident. It requires more astronomy than I am able to lay before the reader, to show, in its particulars, what would be the effect to the system, of a dark body at the centre and one of the planets being luminous ; but I think it manifest, without either plates or calculation, first, that supposing the necessary proportion of magnitude between the central and the revolving bodies to be preserved, the ignited planet would not be sufficient to illuminate and warm the rest of the system ; secondly, that its light and heat would be imparted to the other planets much more irregularly than light and heat are now received from the sun.[85]

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[85] The cut represents the four great planets, as seen through telescopes of considerable powers. Each planet is marked by the symbol which astronomers have for ages been accustomed to use. ♄ is Saturn with his two rings ; which are huge bodies, the larger having a diameter more than 25 times that of our earth, or above 200,000 miles, and moving with prodigious swiftness round the planet. The seven satellites, or moons, are not represented. ♃ is Jupiter with his spots or belts ; his four moons are not represented. Both Saturn and Jupiter

(*) II. Another thing, in which a choice appears to be exercised, and in which, amongst the possibilities out of which the choice was to be made, the number of those which were wrong bore an infinite proportion to the number of those which were right, is in what geometricians call the *axis of rotation*. This matter I will endeavor to explain. The earth, it is well known, is not an exact globe, but an oblate spheroid, something like an orange. Now the axes of rotation, or the diameters upon which such a body may be made to turn round, are as many as

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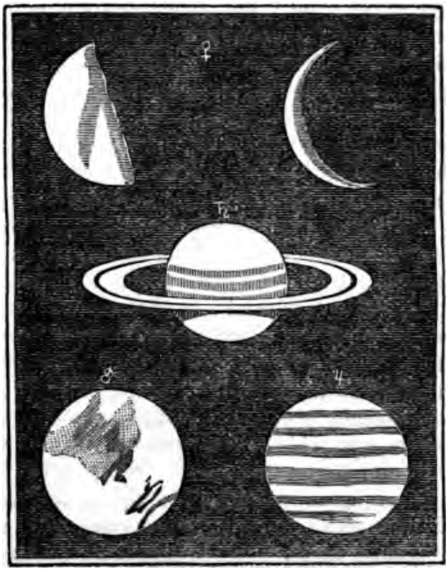
are, like our earth, flattened at the poles, instead of being perfect spheres, owing to their rotatory motion on their axes. ♂ is Mars, with his singularly formed spots, and reddish light at his poles. ♀ is two figures of Venus, as she is seen in different positions ; one like a half-moon, and in the other like a crescent. These *appearances* are called *phases*, from the Greek, and she is the brightest of all the planets. The bulk of Jupiter is 1281 times greater than that of the Earth, of Saturn 995 times ; while that of Venus is nine-tenths, and that of Mars one-half the Earth's bulk. The bulk of the Sun itself is 1,367,000 times that of the earth.—ENG. ED.



can be drawn through its centre to opposite points upon its whole surface; but of these axes none are *permanent*, except either its shortest diameter, *i. e.*, that which passes through the heart of the orange from the place where the stalk is inserted into it, and which is but one; or its longest diameters, at right angles with the former, which must all terminate in the single circumference which goes round the thickest part of the orange. The shortest diameter is that upon which in fact the earth turns, and it is, as the reader sees, what it ought to be, a permanent axis; whereas, had blind chance, had a casual impulse, had a stroke or push at random, set the earth a-spinning, the odds were infinite but that they had sent it round upon a wrong axis. And what would have been the consequence? The difference between a permanent axis and another axis is this: When a spheroid in a state of rotatory motion gets upon a permanent axis, it keeps there; it remains steady and faithful to its position: its poles preserve their direction with respect to the plane and to the centre of its orbit: but, whilst it turns upon an axis which is *not* permanent, (and the number of those we have seen infinitely exceeds the number of the other,) it is always liable to shift and vacillate from one axis to another, with a corresponding change in the inclination of its poles. Therefore, if a planet once set off revolving upon any other than its shortest, or one of its longest axes, the poles on its surface would keep perpetually changing, and it never would attain a permanent axis of rotation. The effect of this unfixedness and instability would be, that the equatorial parts of the earth might become the polar, or the polar the equatorial; to the utter destruction of plants and animals which are not capable of interchanging their situations, but are respectively adapted to their own. As to ourselves, instead of rejoicing in our temperate zone, and annually preparing for the moderate vicissitude, or rather the agreeable succession, of seasons, which we experience and expect, we might come to be locked up in the ice and darkness of the Arctic circle, with bodies neither inured to its rigors, nor provided with shelter or defence against them. Nor would it be much better, if the trepidation of our pole, taking an opposite course, should place us under the heats of a vertical sun. But if it would fare so ill with the human inhabitant, who can live under greater varieties of latitude than any other animal; still more noxious would this translation of climate have proved to life in the rest of the creation; and, most perhaps of all, in plants. The habitable earth, and its beautiful variety, might have been destroyed by a simple mischance in the axis of rotation.[86]

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[86] (Note of Bishop Brinkley.) Either the earth was created a solid, an oblate spheroid, as it now exists, or it must have taken its present form while a soft or fluid mass. In the former case, the argument for design arising from the body revolving on a permanent axis of rotation is of the strongest possible nature. But the present extended knowledge of geology has rendered it highly probable, that the earth was originally an ignited mass in a state of fluidity, ignited to the very surface, and by its rotation in that state took its present form as the result of the mutual attraction of its parts and of its rotatory motion. This must be conceded if we do not admit the choice of a permanent axis of rotation. It is, therefore, in the progress through countless ages of the changes on the surface, from the chaotic or primary formation of the geologists to the most interesting state of the surface as it now exists, that we trace the endless arguments for design. However difficult at first sight to be explained, these changes will, when understood, show *one uniform* system, in which all things work together for good.

If we consider the state of the surface before its cooling in a great degree, it must have been wholly unfitted for animal and vegetable life. The admission of this state necessarily lets in the *posterior* and *successive* creation of vegetables and animals. From the vestiges which remain, we may conclude, with the highest degree of probability, that for a very long period the surface was only adapted for vegetables and the lowest description of animal life; afterwards for animals of an amphibious nature, and such as could exist only on the marshy shores of lakes, or in places occasionally covered with water. By degrees this state of the surface gave way to others more fitted for a further supply of animals *to be created.* The principal origin of these changes appears to have been provided in the powers attached to the substances, of whatever nature they may be, existing in the interior of the earth; but these powers have been merely mechanical, and could not originate organized vegetables and animals. The class of changes at the surface, constituting the tertiary formations of the geologist, appear to have been that which was followed by the introduction of a great variety of large animals, many of which are now extinct. The surface was still to be further improved by making it fitted for a wide extension of animals and of their food. This has been done by the means afforded for the extension and spreading of alluvial matter, so admirably adapted for the growth of plants, and therefore for the existence of animal life. The changes of surface which have been alluded to ar

(*) III. All this, however, proceeds upon a supposition of the earth having been formed at first an oblate spheroid. There is another supposition; and perhaps our limited information will not enable us to decide between them. The second supposition is, that the earth, being a mixed mass somewhat fluid, took, as it might do, its present form, by the joint action of the mutual gravitation of its parts and its rotatory motion. This, as we have said, is a point in the history of the earth, which our observations are not sufficient to determine. For a very small depth below the surface, (but extremely small—less, perhaps, than an eight thousandth part, compared with the depth of the centre,) we find vestiges of ancient fluidity. But this fluidity must have gone down many hundred times further than we can penetrate, to enable the earth to take its present oblate form; and whether any traces of this kind exist to that depth we are ignorant. Calculations were made a few years ago, of the mean density of the earth, by comparing the force of its attraction with the force of attraction of a rock of granite, the bulk of which could be ascertained: and the upshot of the calculation was, that the earth upon an average, through its whole sphere, has twice the density of granite, or above five times that of water. Therefore it cannot be a hollow shell, as some have formerly supposed; nor can its internal parts be occupied by central fire, or by water. The solid parts must greatly exceed the fluid parts: and the probability is, that it is a solid mass throughout, composed of substances more ponderous the deeper we go.

all parts of the same design. Between the successive changes great intervals appear to have elapsed. The imagination is able to form no conception of the length of time since the chaotic state began to change. Notwithstanding the time that must have existed between each change, one uniform plan can be discerned. The animals which we must admit to have been *successively* created, show, by their organization, the same Creator. Thus, if we admit the fluid and chaotic state of the earth, (the alternative if we do not admit an original spheroidal formation,) there cannot be a question as to the powerful arguments to be derived from the change on the surface and its series of organized beings. Indeed, if the matter be well considered, it will appear to many that the most conclusive arguments for design and *continued* superintendence may be deduced from the researches of the modern geologists.—See Note,(93,) to Chap. xxv. *infra.*—Eng. Ed.

Nevertheless, we may conceive the present face of the earth to have originated from the revolution of a sphere covered by a surface of a compound mixture; the fluid and solid parts separating, as the surface becomes quiescent. Here then comes in the *moderating* hand of the Creator. If the water had exceeded its present proportion, even but by a trifling quantity, compared with the whole globe, all the land would have been covered: had there been much less than there is, there would not have been enough to fertilize the continent. Had the exsiccation been progressive, such as we may suppose to have been produced by an evaporating heat, how came it to stop at the point at which we see it? Why did it not stop sooner? why at all? The mandate of the Deity will account for this; nothing else will.

IV. OF CENTRIPETAL FORCES. By virtue of the simplest law that can be imagined, viz., that a body *continues* in the state in which it is, whether of motion or rest; and, if in motion, goes on in the line in which it was proceeding and with the same velocity, *unless* there be some cause for change; by virtue, I say, of this law, it comes to pass, (what may appear to be a strange consequence,) that cases arise, in which attraction, incessantly drawing a body towards a centre, never brings, nor ever will bring, the body to that centre, but keep it in eternal circulation round it. If it were possible to fire off a cannon-ball with a velocity of five miles in a second, and the resistance of the air could be taken away, the cannon-ball would for ever wheel round the earth instead of falling down upon it. This is the principle which sustains the heavenly motions. The Deity, having appointed this law to matter, (than which, as we have said before, no law could be more simple,) has turned it to a wonderful account in constructing planetary systems.

The actuating cause in these systems is an attraction which varies reciprocally as the square of the distance; that is, at double the distance, has a quarter of the force; at half the distance, four times the strength: and so on. Now concerning this law of variation, we have three things to observe; first, that attraction, for any thing we know about it, was just as capable of one law of variation as of another; secondly, that, out of an infinite number of possible laws, those which were admissible for the purpose of supporting the heavenly motions lay within certain narrow limits; thirdly, that of the admissible laws, or those which come within the limits prescribed, the law that actually prevails is the most beneficial. So far as these propositions can be made out, we may be said, I think, to prove *choice*, and *regulation*: choice, out of boundless variety; and regulation, of that which, by its own nature, was, in respect of the property regulated, indifferent and indefinite.

I. First, then, attraction, for any thing we know about it, was originally indifferent to all laws of variation depending upon change of distance, *i. e.*, just as susceptible of one law as of another. It might have been the same at all distances; it might have increased as the distance increased: or it might have diminished with the increase of the distance, yet in ten thousand different proportions from the present; it might have followed no stated law at all. If attraction be what Cotes, with many other Newtonians, thought it to be, a primordial property of matter, not dependent upon, or traceable to, any other material cause; then, by the very nature and definition of a primordial property, it stood indifferent to all laws. If it be the agency of something immaterial; then also, for any thing we know of it, it was indifferent to all laws. If the revolution of bodies round a centre depend upon vortices, neither are these limited to one law more than another.

There is, I know, an account given of attraction, which should seem, in its very cause, to assign to it the law which we find it to observe; and which therefore makes that law, a law, not of choice, but of necessity; and it is the account which ascribes attraction to an *emanation* from the attracting body. It is probable that the influence of such an emanation will be proportioned to the spissitude of the rays of which it is composed; which spissitude, supposing the rays to issue in right lines on all sides from a point, will be reciprocally as the square of the distance. The mathematics of this solution we do not call in question: the *question with us* is, whether there be any sufficient reason for believing that attraction is produced by an emanation. For my part, I am totally at a loss to comprehend how particles streaming *from* a centre should draw a body *towards* it. The impulse, if impulse it be, is all the other way. Nor shall we find less difficulty in conceiving a conflux of particles, incessantly flowing to a centre, and carrying down all bodies along with it, that centre also itself being in a state of rapid motion through absolute space : for, by what source is the stream fed, or what becomes of the accumulation ? Add to which, that it seems to imply a contrariety of properties, to suppose an ethereal fluid to *act* but not to *resist* ; powerful enough to carry down bodies with great force towards a centre, yet, inconsistently with the nature of inert matter, powerless and perfectly yielding with respect to the motions which result from the projectile impulse. By calculations drawn from ancient notices of eclipses of the moon, we can prove that, if such a fluid exist at all, its resistance has had no sensible effect upon the moon's motion for two thousand five hundred years. The truth is, that except this one circumstance of the variation of the attracting force at different distances agreeing with the variation of the spissitude, there is no reason whatever to support the hypothesis of an emanation ; and, as it seems to me, almost insuperable reasons against it.

(*) II. Our second proposition is, that, whilst the possible laws of variation were infinite, the *admissible* laws, or the laws compatible with the preservation of the system, lie within narrow limits. If the attracting force had varied according to any *direct* law of the distance, let it have been what it would, great destruction and confusion would have taken place. The direct simple proportion of the distance would, it is true, have produced an ellipse : but the perturbing forces would have acted with so much advantage, as to be continually changing the dimensions of the ellipse, in a manner inconsistent with our terrestrial creation. For instance ; if the planet Saturn, so large and so remote, had attracted the earth, both in proportion to the quantity of matter contained in it, which it does ; and also in any proportion to its distance, *i. e.*, if it be pulled the harder for being the further off, (instead of the reverse of it,) it would have dragged out of its course the globe which we inhabit, and have perplexed its motions, to a degree incompatible with our security, our enjoyments, and probably our existence. Of the *inverse* laws, if the centripetal force had changed as the cube of the distance, or in any higher proportion, that is, (for I speak to the unlearned,) if, at double the distance, the attractive force had been diminished to an eighth part, or to less than that, the consequence would have been, that the planets, if they once began to approach the sun, would have fallen into his body; if they once, though by ever so little, increased their distance from the centre, would for ever have receded from it. The laws therefore of attraction, by which a system of revolving bodies could be upholden in their motions, lie within narrow limits, compared with the possible laws. I much underrate the restriction, when I say that, in a scale of a mile, they are confined to an inch. All direct ratios of the distance are excluded, on account of danger from perturbing forces: all reciprocal ratios, except what lie beneath the cube of the distance, by the demonstrable consequence, that every the least change of distance would, under the operation of such laws, have been fatal to the repose and order of the system. We do not know, that is, we seldom reflect, how interested we are in this matter. Small irregularities may be endured; but, changes within these limits being allowed for, the permanency of our ellipse is a question of life and death to our whole sensitive world.

(*) III. That the subsisting law of attraction falls within the limits which utility requires, when these limits bear so small a proportion to the range of possibilities upon which chance might equally have cast it, is not, with any appearance of reason, to be accounted for, by any other cause than a regulation proceeding from a designing mind. But our next proposition carries the matter somewhat further. We say, in the third place, that, out of the different laws which lie within the limits of admissible laws, the *best* is made choice of; that there are advantages in this particular law which cannot be demonstrated to belong to any other law; and, concerning some of which, it can be demonstrated that they do not belong to any other.

(*) 1. Whilst this law prevails between each particle of matter, the *united* attraction of a sphere, composed of that matter, observes the same law. This property of the law is necessary, to render it applicable to a system composed of spheres, but it is a property which belongs to no other law of attraction that is admissible. The law of variation of the united attraction, is in no other case the same as the law of attraction of each particle, one case excepted, and that is, of the attraction varying directly as the distance; the inconveniency of which law, in other respects, we have already noticed.

We may follow this regulation somewhat further, and still more strikingly perceive that it proceeded from a designing mind. A law both admissible and convenient was requisite. In what way is the law of the attracting globes obtained? Astronomical observations and terrestrial experiments show, that the attraction of the globes of the system is made up of the attraction of their parts; the attraction of each globe being compounded of the attractions of its parts. Now the admissible and convenient law which exists, could not be obtained in a system of bodies gravitating by the united gravitation of their parts, unless each particle of matter were attracted by a force varying by one particular law, *viz.*, varying inversely as the square of the distance: for, if the action of the particles be according to any other law whatever, the admissible and convenient law, which is adopted, could not be obtained. Here then are clearly shown regulation and design. A law both admissible and convenient was to be obtained; the mode chosen for obtaining that law was by making *each* particle of matter act. After this choice was made, then further attention was to be given to each particle of matter, and one, and one only, particular law of action to be assigned to it. No other law would have answered the purpose intended.

(*) 2. All systems must be liable to *perturbations.* And therefore, to guard against these perturbations, or rather to guard against their running to destructive lengths, is perhaps the strongest evidence of care and foresight that can be given. Now, we are able to demonstrate of our law of attraction, what can be demonstrated of no other, and what qualifies the dangers which arise from cross but unavoidable influences; that the action of the parts of our system upon one another, will not cause permanently increasing irregularities, but merely periodical or vibratory ones; that is, they will come to a limit, and then go back again. This we can demonstrate only of a system, in which the following properties concur, *viz.*, that the force shall be inversely as the square of the distance; the masses of the revolving bodies small, compared with that of the body at the centre; the orbits not much inclined to one another; and their eccentricity little. In such a system, the grand points are secure. The mean distances and periodic times, upon which depend our temperature, and the regularity of our year, are constant. The eccentricities, it is true, will still vary; but so slowly, and to so small an extent, as to produce no inconveniency from fluctuation of temperature and season. The same as to the obliquity of the planes of the orbits. For instance, the inclination of the ecliptic to the equator will never change above two degrees, (out of ninety,) and that will require many thousand years in performing.

It has been rightly also remarked, that, if the great planets, Jupiter and Saturn, had moved in lower spheres, their influences would have had much more effect as to disturbing the planetary motions, than they now have. While they revolve at so great distances from the rest, they act almost equally on the sun and on the inferior planets; which has nearly the same consequence as not acting at all upon either.

If it be said, that the planets might have been sent round the sun in exact circles, in which case, no change of distance from the centre taking place, the law of variation of the attracting power would have never come in question, one law would have served as well as another; an answer to the scheme may be drawn from the consideration of these same perturbing forces. The system retaining in other respects its present constitution, though the planets had been at first sent round in exact circular orbits, they could not have kept them; and if the law of attraction had not been what it is, or at least, if the prevailing law had transgressed the limits above assigned, every evagation would have been fatal: the planet, once drawn, as drawn it necessarily must have been, out of its course, would have wandered in endless error.[87]

(*) V. What we have seen in the law of the centripetal force, *viz.*, a choice guided by views of utility, and a choice of one law out of thousands which might equally have taken place, we see no less in the *figures* of the planetary orbits. It was not enough to fix the law of the centripetal force, though by the wisest choice; for, even under that law, it was still competent to the planets to have moved in paths possessing so great a degree of eccentricity, as, in the course of every revolution, to be brought very near to the sun, and carried away to immense distances from him. The comets actually move in orbits of this sort: and, had the planets done so, instead of going round in orbits nearly circular, the change from one extremity of temperature to another must, in ours at least, have destroyed every animal and plant upon its surface. Now the distance from the centre at which a planet sets off, and the absolute force of attraction at that distance, being fixed, the figure of its orbit, its being a circle, or nearer to, or further off from a circle, *viz.*, a rounder or a longer oval, depends upon two things; the velocity with which, and the direction in which, the planet is projected. And these, in order to produce a *right* result, must be both brought within certain narrow limits. One, and only one, velocity, united with one, and only one, direction, will produce a perfect circle. And the velocity must be near to this velocity, and the direction also near to this direction, to produce orbits, such as the planetary orbits are, nearly circular; that is, ellipses with small eccentricities. The velocity and the direction must both be right. If the velocity be wrong, no direction will cure the error; if the direction be in any considerable degree oblique, no velocity will produce the orbit required. Take, for example, the attraction of gravity at the surface of the earth. The force of that attraction being what it is, out of all the degrees of velocity, swift and slow, with which a ball might be shot off, none would answer the purpose of which we are speaking, but what was nearly that of five miles in a second. If it were less than that, the body would not get round at all, but would come to the ground; if it were in any considerable degree more than that, the body would take one of those eccentric courses, those long ellipses, of which we have noticed the inconveniency. If the velocity reached the rate of seven miles in a second, or went beyond that, the ball would fly off from the earth, and never be heard of more. In like manner with respect to the *direction*; out of the innumerable angles in which the ball might be sent off, (I mean angles formed with a line drawn in the centre,) none would serve but what was nearly a right one; out of the various directions in which the cannon might be pointed, upwards and downwards, every one would fail, but what was exactly or nearly horizontal. The same thing holds true of the planets: of our own amongst the est. We are entitled therefore to ask, and to urge the question, Why did the projectile velocity and projectile direction of the earth happen to be nearly those which would retain it in a *circular* form? Why not one of the infinite number of velocities, one of the infinite number of directions, which would have made it approach much nearer to, or recede much further from, the sun?

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[87] (Note of Bishop Brinkley.) Many suppose attraction an emanation, and the law of attraction (the inverse square of the distance) which exists, to be actually *necessary* and deducible from *equal* quantities of the attractive force being spread over each spherical surface surrounding the attractive centre. If this were so, all attracting matter must act according to the same law. This is not the case in many instances that might be adduced. The attraction by which particles of matter adhere together is obviously not of this nature. Chemical action furnishes many exceptions to this law. It may, indeed, be said that a polarizing power may be joined to an attractive force, acting as above-mentioned. We know very imperfectly, or rather nothing, of the nature of this polarization; but we know it is not extended to the actions of the sun and planetary masses on each other. Why was it not extended to these? The simple answer is, that it would not only have been useless, but it would have interfered with the purposes for which these bodies were designed. Thus these great bodies are moved by laws of the utmost simplicity, while their component parts act on each other by a combination of forces of various kinds; which forces appear to act at small distances only, while the forces on which depend the welfare and preservation of our earth and the planets, act through a vast extent of space, and by one simple and uniform law, in which there is no conflicting interference of other actions.—ENG. ED.

The planets going round, all in the same direction and all nearly in the same plane, afforded to Buffon a ground for asserting, that they had all been shivered from the sun by the same stroke of a comet, and by that stroke projected into their present orbits. Now, besides that this is to attribute to chance the fortunate concurrence of velocity and direction which we have been here noticing, the hypothesis, as I apprehend, is inconsistent with the physical laws by which the heavenly motions are governed. If the planets were struck off from the surface of the sun, they would return to the surface of the sun again. Nor will this difficulty be got rid of, by supposing that the same violent blow which shattered the sun's surface, and separated large fragments from it, pushed the sun himself out of his place; for, the consequence of this would be, that the sun and system of shattered fragments would have a progressive motion, which, indeed, may possibly be the case with our system; but then each fragment would, in every revolution, return to the surface of the sun again. The hypothesis is also contradicted by the vast difference which subsists between the *diameters* of the planetary orbits. The distance of Saturn from the sun (to say nothing of the Georgium Sidus) is nearly five-and-twenty times that of Mercury; a disparity, which it seems impossible to reconcile with Buffon's scheme. Bodies starting from the same place, with whatever difference of direction or velocity they set off, could not have been found at these different distances from the centre, still retaining their nearly circular orbits. They must have been carried to their proper distances, before they were projected.*

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* "If we suppose the matter of the system to be accumulated in the centre by its gravity, *no* mechanical principles, with the assistance of this power of gravity, could separate the vast mass into such parts as the sun and planets;

To conclude: In astronomy, the great thing is to raise the imagination to the subject, and that oftentimes in opposition to the impression made upon the senses. An illusion, for example, must be gotten over arising from the distance at which we view the heavenly bodies, *viz.*, the apparent *slowness* of their motions. The moon shall take some hours in getting half a yard from a star which it touched. A motion so deliberate we may think easily guided. But what is the fact? The moon, in fact, is, all this while, driving through the heavens at the rate of considerably more than two thousand miles in an hour; which is more than double of that with which a ball is shot off from the mouth of a cannon. Yet is this prodigious rapidity as much under government, as if the planet proceeded ever so slowly, or were conducted in its course inch by inch. It is also difficult to bring the imagination to conceive (what yet, to judge tolerably of the matter, it is necessary to conceive) how *loose*, if we may so express it, the heavenly bodies are. Enormous globes, held by nothing, confined by nothing, are turned into free and boundless space, each to seek its course by the virtue of an invisible principle; but a principle, one, common, and the same in all, and ascertainable. To preserve such bodies from being lost, from running together in heaps, from hindering and distracting one another's motions, in a degree inconsistent with any continuing order; *h. e.*, to cause them to form planetary systems, systems that, when formed, can be upheld, and, most especially, systems accommodated to the organized and sensitive natures, which the planets sustain, as we know to be the case, where alone we can know what the case is, upon our earth: all this requires an intelligent interposition, because it can be demonstrated concerning it, that it requires an adjustment of force, distance, direction, and

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and, after carrying them to their different distances, project them in their several directions, preserving still the quality of action and reaction, or the state of the centre of gravity of the system. Such an exquisite structure of things could only arise from the contrivance and powerful influences of an intelligent, free, and most potent agent. The same powers, therefore, which, at present, govern the material universe, and conduct its various motions, are *very different* from those which were necessary to have produced it from nothing, or to *have disposed it in the* admirable form in which it now proceeds."—*Maclaurin's Account of Newton's Philosophy*, p. 407, ed. 3.

velocity, out of the reach of chance to have produced; an adjustment, in its view to utility, similar to that which we see in ten thousand subjects of nature which are nearer to us, but in power, and in the extent of space through which that power is exerted, stupendous.[88]

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[88] (Note of Bishop Brinkley.) Since the publication of Dr. Paley's 'Natural Theology,' it has been ascertained that a resisting medium is actually diffused through our system. But it is of so rare a nature, that the planets will not be affected by it for an immense period. The existence of this resisting medium has been ascertained by the successive revolutions of the small comet, the orbit of which was first accurately computed by M. Encke, and its identity verified on several successive returns. We had before a knowledge of the weak action of comets on the planets, and of the consequent smallness of their masses. It was also inferred, that they were bodies of small density, and consequently would be more sensibly affected in their motions through a resisting medium. This comet was found in 1795 by Miss Herschel, and observed also by her brother. His account of it, when considered with reference to what has since been ascertained, as to the resistance it meets with in its course, is remarkable. (vide Phil. Trans. 1796, p. 133.) "The comet is now centrically on a small star. It is a small telescopic star of about the eleventh or twelfth magnitude, and is double, very unequal; with a power of two hundred and eighty-seven, I can see the smallest of the two stars perfectly well. This shows how little density there is in the comet, which is evidently nothing but what may be called a collection of vapors." This comet is also remarkable for the shortness of its period, about three and a half years, not receding so far from the sun as the planet Jupiter. In the solar system, the difference between the two classes of bodies which revolve round the sun, and are retained in their orbits by the solar action, is most marked and distinct. Comets so numerous serve for purposes entirely unknown to us. Indeed, hitherto no probable conjecture has been formed as to those purposes. That they are not the habitations of beings similar to those which exist on the earth is nearly certain. The earth and planets appear wisely adapted, in a variety of ways, for the convenience and preservation of animals and vegetables. The comets are not so adapted. In one case, orbits nearly circular were required, in the other they were not required.

There is another circumstance in which design appears strongly marked, although we cannot explain the purport of it. The planets appear to be placed at distances from the sun, according to a certain law. This was remarked by Professor Bode, and that the law was not complete unless a planet existed between Mars and Jupiter. The new planets were afterwards discovered, each of them circulating between Jupiter and Mars, at a distance from the sun, conformable to the conjectured law. The cause of more than one planet being found at this distance has, with some degree of probability, been derived from the hypothesis, that a large planet has been shattered into fragments, which fragments are the planets Ceres, Vesta, Pallas, and Juno

But many of the heavenly bodies, as the sun and fixed stars, are *stationary*. Their rest must be the effect of an absence or of an equilibrium of attractions. It proves also, that a projectile impulse was originally given to some of the heavenly bodies, and not to others. But further: if attraction act at all distances, there can only be one quiescent centre of gravity in the universe; and all bodies whatever must be approaching this centre or revolving round it. According to the first of these suppositions, if the duration of the world had been long enough to allow of it, all its parts, all the great bodies of which it is composed, must have been gathered together in a heap round this point. No changes however which have been observed, afford us the smallest reason for believing, that either the one supposition or the other is true: and then it will follow, that attraction itself is controlled or suspended by a superior agent; that there is a power above the highest of the powers of material nature; a will which restrains and circumscribes the operations of the most extensive.*

That wonderful changes occasionally offer themselves to our notice, as wonderful as the destruction of a planet, is exemplified in the appearance and disappearance of a fixed star. A star suddenly appeared, in 1571, of a degree of splendor exceeding all the other fixed stars. It was seen during sixteen months, and continually diminished in brightness till it disappeared. All the circumstances of it are well attested by many astronomers, and others. It remained fixed in one spot of the heavens, without changing its place among the other stars by any perceptible quantity. Although astronomical instruments, at that time, did not admit of a degree of precision to be compared with those of the present time, yet the observations made on it by several astronomers fully suffice to show, that its distance from us, must have been at least between three and four thousand times that of the sun from the earth, or 300,000 millions of miles.—Eng. Ed.

* It must here, however, be stated, that many astronomers deny that any of the heavenly bodies are absolutely stationary. Some of the brightest of the fixed stars have certainly small motions; and of the rest the distance is too great, and the intervals of our observation too short, to enable us to pronounce with certainty that they may not have the same. The motions in the fixed stars which have been observed, are considered either as proper to each of them, or as compounded of the motion of our system, and of motions proper to each star. By a comparison of these motions, a motion in our system is supposed to be discovered. By continuing this analogy to other, and to all systems, it is possible to suppose that attraction is unlimited, and that the whole material universe is revolving round some fixed point within its containing sphere or space.—*Note of the Author.*

CHAPTER XXIII.

OF THE PERSONALITY OF THE DEITY.

CONTRIVANCE, if established, appears to me to prove every thing which we wish to prove. Amongst other things, it proves the *personality* of the Deity, as distinguished from what is sometimes called Nature, sometimes called a principle : which terms, in the mouths of those who use them philosophically, seem to be intended, to admit and to express an efficacy, but to exclude and to deny a personal agent. Now that which can contrive, which can design, must be a person. These capacities constitute personality, for they imply consciousness and thought. They require that which can perceive an end or purpose ; as well as the power of providing means, and directing them to their end.* They require a centre in which perceptions unite, and from which volitions flow ; which is mind. The acts of a mind, prove the existence of a mind ; and in whatever a mind resides, is a person. The seat of intellect is a person. We have no authority to limit the properties of mind to any particular corporeal form, or to any particular circumscription of space. These properties subsist, in created nature, under a great variety of sensible forms. Also every animated being has its *sensorium ;* that is, a certain portion of space, within which perception and volition are exerted. This sphere may be enlarged to an indefinite extent ; may comprehend the universe ; and, being so imagined, may serve to furnish us with as good a notion, as we are capable of forming, of the *immensity* of the Divine Nature, *i. e.*, of a Divine Being, infinite, as well in essence as in power ; yet nevertheless a person.

"No man hath seen God at any time." And this, I believe, makes the great difficulty. Now it is a difficulty which chiefly arises from our not duly estimating the state of our faculties. The Deity, it is true, is the object of none of our senses: but reflect what limited capacities animal senses are. Many animals seem to have but one sense, or perhaps two at the most; touch and taste. Ought such an animal to conclude against the existence of odors, sounds, and colors? To another species is given the sense of smelling. This is an advance in the knowledge of the powers and properties of nature: but, if this favored animal should infer, from its superiority over the class last described, that it perceived every thing which was perceptible in nature, it is known to us, though perhaps not suspected by the animal itself, that it proceeded upon a false and presumptuous estimate of its faculties. To another is added the sense of hearing; which lets in a class of sensations entirely unconceived by the animal before spoken of; not only distinct, but remote from any which *it* had ever experienced, and greatly superior to them. Yet this last animal has no more ground for believing that its senses comprehend all things, and all properties of things, which exist, than might have been claimed by the tribes of animals beneath it; for we know that it is still possible to possess another sense, that of sight, which shall disclose to the percipient a new world. This fifth sense makes the animal what the human animal is: but to infer that possibility stops here; that either this fifth sense is the last sense, or that the five comprehend all existence,—is just as unwarrantable a conclusion as that which might have been made by any of the different species which possessed fewer, or even by that, if such there be, which possessed only one. The conclusion of the one-sense animal, and the conclusion of the five-sense animal, stand upon the same authority. There may be more and other senses than those which we have. There may be senses suited to the perception of the powers, properties, and substance, of spirits. These may belong to higher orders of rational agents; for there is not the smallest reason for supposing that we are the highest, or that the scale of creation stops with us.

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* Priestley's Letters to a Philosophical Unbeliever.

The great *energies* of Nature are known to us only by their effects. The substances which produce them, are as much concealed from our senses as the Divine essence itself. *Gravitation*, though constantly present, though constantly exerting its influence, though every where around us, near us, and within us; though diffused throughout all space, and penetrating the texture of all bodies with which we are acquainted, depends, if upon a fluid, upon a fluid which, though both powerful and universal in its operation, is no object of sense to us; if upon any other kind of substance or action, upon a substance and action from which *we* receive no distinguishable impressions. Is it then to be wondered at that it should, in some measure, be the same with the Divine nature?

Of this, however, we are certain, that whatever the Deity be, neither the *universe*, nor any part of it which we see, can be He. The universe itself is merely a collective name: its parts are all which are real; or which are *things*. Now inert matter is out of the question; and organized substances include marks of contrivance. But whatever includes marks of contrivance, whatever, in its constitution, testifies design, necessarily carries us to something beyond itself, to some other being, to a designer prior to, and out of itself. No animal, for instance, can have contrived its own limbs and senses; can have been the author to itself of the design with which they were constructed. That supposition involves all the absurdity of self-creation, *i. e.*, of acting without existing. Nothing can be God, which is ordered by a wisdom and a will, which itself is void of; which is indebted for any of its properties to contrivance *ab extra*. The *not* having that in his nature which requires the exertion of another prior being (which property is sometimes called self-sufficiency, and sometimes self-comprehension) appertains to the Deity, as his essential distinction, and removes his nature from that of all things which we see. Which consideration contains the answer to a question that has sometimes been asked, namely, Why, since something or other must have existed from eternity, may not the present universe be that something? The contrivance perceived in it proves that to be impossible. Nothing contrived can, in a strict and proper sense, be eternal, forasmuch as the contriver must have existed before the contrivance.

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will produce different motions and different results, according to the variety of the intermediate mechanism. One and the selfsame spring, acting in one and the same manner, *viz.*, by simply expanding itself, may be the cause of a hundred different and all useful movements, if a hundred different and well-devised sets of wheels be placed between it and the final effect: *e. g.*, may point out the hour of the day, the day of the month, the age of the moon, the position of the planets, the cycle of the years, and many other serviceable notices; and these movements may fulfil their purposes with more or less perfection, according as the mechanism is better or worse contrived, or better or worse executed, or in a better or worse state of repair: *but in all cases it is necessary that the spring act at the centre.* The course of our reasoning upon such a subject would be this: By inspecting the watch, even when standing still, we get a proof of contrivance, and of a contriving mind having been employed about it. In the form and obvious relation of its parts, we see enough to convince us of this. If we pull the works in pieces, for the purpose of a closer examination, we are still more fully convinced. But, when we see the watch *going*, we see proof of another point, *viz.*, that there is a power somewhere, and somehow or other applied to it; a power in action;—that there is more in the subject than the mere wheels of the machine;—that there is a secret spring, or a gravitating plummet;—in a word, that there is force, and energy, as well as mechanism.

So, then, the watch in motion establishes to the observer two conclusions: One,—that thought, contrivance, and design, have been employed in the forming, proportioning, and arranging of its parts; and that whoever or wherever he be, or were, such a contriver there is or was: The other,—that force or power, distinct from mechanism, is, at this present time, acting upon it. If I saw a hand-mill even at rest, I should see contrivance: but if I saw it grinding, I should be assured that a hand was at the windlass, though in another room. It is the same in nature. In the works of Nature we trace mechanism; and this alone proves contrivance: but living, active, moving, productive nature, proves also the exertion of a power at the centre: for, wherever the power resides, may be denominated the centre.

The intervention and disposition of what are called "*second causes*" fall under the same observation. This disposition is or is not mechanism, according as we can or cannot trace it by our senses and means of examination. That is all the difference there is; and it is a difference which respects our faculties, not the things themselves. Now where the order of second causes is mechanical, what is here said of mechanism strictly applies to it. But it would be always mechanism, (natural chemistry, for instance, would be mechanism,) if our senses were acute enough to descry it. Neither mechanism, therefore, in the works of Nature, nor the intervention of what are called second causes, (for I think that they are the same thing,) excuses the necessity of an agent distinct from both.

If, in tracing these causes, it be said, that we find certain general properties of matter, which have nothing in in them that bespeaks intelligence, I answer, that still the *managing* of these properties, the pointing and directing them to the uses which we see made of them, demands intelligence in the highest degree. For example: suppose animal secretions to be elective attractions, and that such and such attractions universally belong to such and such substances—in all which there is no intellect concerned; still the choice and collocation of these substances, the fixing upon right substances, and disposing them in right places, must be an act of intelligence. What mischief would follow, were there a single transposition of the secretory organs; a single mistake in arranging the glands which compose them!

There may be many second causes, and many courses of second causes, one behind another, between what we observe of Nature, and the Deity: but there must be intelligence somewhere: there must be more in Nature than what we see; and, amongst the things unseen, there must be an intelligent, designing author. The philosopher beholds with astonishment the production of things around him. Unconscious particles of matter take their stations, and severally range themselves in an order so as to become collectively plants or animals, *i. e.*, organized bodies, with parts bearing strict and evident relation to one another, and to the utility of the whole: and it should seem, that these particles could not move in any other way than as they do; for they testify not the smallest sign of choice, or liberty, or discretion. There may be particular intelligent beings, guiding these motions in each case: or they may be the result of trains of mechanical dispositions, fixed beforehand by an intelligent appointment, and kept in action by a power at the centre. But, in either case, there must be intelligence.

The minds of most men are fond of what they call a *principle*, and of the appearance of simplicity, in accounting for phenomena. Yet this principle, this simplicity, resides merely in the *name*; which name, after all, comprises, perhaps, under it, a diversified, multifarious, or progressive operation, distinguishable into parts. The power in organized bodies, of producing bodies like themselves, is one of these principles. Give a philosopher this, and he can get on. But he does not reflect what this mode of production, this principle (if such he choose to call it) requires; how much it presupposes; what an apparatus of instruments, some of which are strictly mechanical, is necessary to its success; what a train it includes of operations and changes, one succeeding another, one related to another, one ministering to another; all advancing, by intermediate, and, frequently, by sensible steps, to their ultimate result! Yet, because the whole of this complicated action is wrapped up in a single term, *generation*, we are to set it down as an elementary principle; and to suppose, that when we have resolved the things which we see into this principle, we have sufficiently accounted for their origin, without the necessity of a designing, intelligent Creator. The truth is, generation is not a principle but a *process*. We might as well call the casting of metals a principle; we might, so far as appears to me, as well call spinning and weaving, principles: and then, referring the texture of cloths, the fabric of muslins and calicoes, the patterns of diapers and damasks, to these, as principles, pretend to dispense with intention, thought, and contrivance, on the part of the artist; or to dispense, indeed, with the necessity of any artist at all, either in the manufacturing of the article, or in the fabrication of the machinery by which the manufacture was carried on.

And, after all, how, or in what sense is it true, that animals produce their *like*? A butterfly, with a proboscis instead of a mouth, with four wings and six legs, produces a hairy caterpillar, with jaws and teeth, and fourteen feet. A frog produces a tadpole. A black beetle, with gauze wings, and a crusty covering, produces a white, smooth, soft worm; an ephemeron fly, a cod-bait maggot. These, by a progress through different stages of life, and action, and enjoyment, (and, in each state, provided with implements and organs appropriated to the temporary nature which they bear,) arrive at last at the form and fashion of the parent animal. But all this is process, not principle; and proves, moreover, that the property of animated bodies, of producing their like, belongs to them, not as a primordial property, not by any blind necessity in the nature of things, but as the effect of economy, wisdom, and design; because the property itself assumes diversities, and submits to deviations dictated by intelligible utilities, and serving distinct purposes of animal happiness.

The opinion, which would consider "generation" as a *principle* in Nature; and which would assign this principle as the cause, or endeavor to satisfy our minds with such a cause, of the existence of organized bodies; is confuted, in my judgement, not only by every mark of contrivance discoverable in those bodies, for which it gives us no contriver, offers no account whatever; but also by the further consideration, that things generated possess a clear relation to things *not* generated. If it were merely one part of a generated body, bearing a relation to another part of the same body; as the mouth of an animal to the throat, the throat to the stomach, the stomach to the intestines, those to the recruiting of the blood, and, by means of the blood, to the nourishment of the whole frame; or, if it were only one generated body bearing a relation to another generated body; as the sexes of the same species to each other, animals of prey to their prey, herbivorous and granivorous animals to the plants or seeds upon which they feed; it might be contended, that the whole of this correspondency was attributable to generation, the common origin from which these substances proceeded. But what shall we say, to agreements which exist between things generated and things *not generated*? Can it be doubted, was it ever doubted, but the *lungs* of animals bear a relation to the *air*, as a permanently elastic fluid? They act in it and by it; they cannot act without it. Now, if generation produce the animal, it did not produce the air: yet their properties correspond. The *eye* is made for *light*, and light for the eye. The eye would be of no use without light, and light perhaps of little without eyes; yet one is produced by generation, the other not. The *ear* depends upon *undulations* of air. Here are two sets of motions; first, of the pulses of air; secondly, of the drum, bones, and nerves of the ear; sets of motions bearing an evident reference to each other: yet the one, and the apparatus for the one, produced by the intervention of generation; the other, altogether independent of it.

If it be said, that the air, the light, the elements, the world itself, is *generated;* I answer, that I do not comprehend the proposition. If the term mean any thing similar to what it means when applied to plants or animals, the proposition is certainly without proof: and, I think, draws as near to absurdity as any proposition can do, which does not include a contradiction in its terms. I am at a loss to conceive how the formation of the world can be compared to the generation of an animal. If the term generation signify something quite different from what it signifies on ordinary occasions, it may, by the same latitude signify any thing. In which case, a word or phrase taken from the language of Otaheite, would convey as much theory concerning the origin of the universe, as it does to talk of its being generated.

We know a cause (intelligence) adequate to the appearances which we wish to account for: we have this cause continually producing similar appearances: yet, rejecting this cause, the sufficiency of which we know, and the action of which is constantly before our eyes, we are invited to resort to suppositions destitute of a single fact for their support, and confirmed by no analogy with which we are acquainted. Were it necessary to inquire into the *motives* of men's opinions, I mean their motives separate from their arguments; I should almost suspect, that, because the proof of a Deity drawn from the constitution of nature is not only popular but vulgar, (which may arise from the cogency of the proof, and be indeed its highest recommendation,) and because it is a species almost of *puerility* to take up with it; for these reasons, minds, which are habitually in search of invention and originality, feel a resistless inclination to strike off into other solutions and other expositions. The truth is, that many minds are not so indisposed to any thing which can be offered to them, as they are to the *flatness* of being content with common reasons: and, what is most to be lamented, minds conscious of superiority, are the most liable to this repugnancy.

The "suppositions" here alluded to, all agree in one character; they all endeavor to dispense with the necessity in Nature of a particular, personal intelligence; that is to say, with the exertion of an intending, contriving mind, in the structure and formation of the organized constitutions which the world contains. They would resolve all productions into *unconscious* energies, of a like kind, in that respect, with attraction, magnetism, electricity, &c.; without any thing further.

In this, the old system of atheism and the new agree. And I much doubt whether the new schemes have advanced any thing upon the old, or done more than changed the terms of the nomenclature. For instance, I could never see the difference between the antiquated system of atoms, and Buffon's organic molecules. This philosopher, having made a planet by knocking off from the sun a piece of melted glass, in consequence of the stroke of a comet; and having set it in motion, by the same stroke, both round its own axis and the sun; finds his next difficulty to be, how to bring plants and animals upon it. In order to solve this difficulty, we are to suppose the universe replenished with particles endowed with life, but without organization or senses of their own; and endowed also with a tendency to marshal themselves into organized forms. The concourse of these particles, by virtue of this tendency, but without intelligence, will, or direction, (for I do not find that any of these qualities are ascribed to them,) has produced the living forms which we now see.

Very few of the conjectures, which philosophers hazard upon these subjects, have more of pretension in them, than the challenging you to show the direct impossibility of the hypothesis. In the present example, there seemed to be a positive objection to the whole scheme upon the very face of it; which was that, if the case were as here represented, *new* combinations ought to be perpetually taking place; new plants and animals, or organized bodies which were neither, ought to be starting up before our eyes every day. For this, however, our philosopher has an answer. Whilst so many forms of plants and animals are already in existence, and, consequently, so many "internal moulds," as he calls them, are prepared and at hand, the organic particles run into these moulds, and are employed in supplying an accession of substance to them, as well for their growth, as for their propagation. By which means, things keep their ancient course. But, says the same philosopher, should any general loss or destruction of the present constitution of organized bodies take place, the particles, for want of "moulds" into which they might enter, would run into different combinations, and replenish the waste with new species of organized substances.

Is there any history to countenance this notion? Is it known that any destruction has been so repaired? any desert thus repeopled?

So far as I remember, the only natural appearance mentioned by our author, by way of fact whereon to build his hypothesis, is the formation of *worms* in the intestines of animals, which is here ascribed to the coalition of superabundant organic particles, floating about in the first passages; and which have combined themselves into these simple animal forms, for want of internal moulds, or of vacancies in those moulds, into which they might be received. The thing referred to is rather a species of facts, than a single fact; as some other cases may, with equal reason, be included under it. But to make it a fact at all, or, in any sort, applicable to the question, we must begin with asserting an *equivocal* generation, contrary to analogy, and without necessity: contrary to an analogy, which accompanies us to the very limits of our knowledge or inquiries; for wherever, either in plants or animals, we are able to examine the subject, we find procreation from a parent form: without necessity; for I apprehend that it is seldom difficult to suggest methods by which the eggs, or spawn, or yet invisible rudiments of these vermin, may have obtained a passage into the cavities in which they are found.* Add to this, that their *constancy to their species*, which, I believe, is as regular in these as in the other vermes, decides the question against our philosopher, if, in truth, any question remained upon the subject.

Lastly; these wonder-working instruments, these "internal moulds," what are they after all? what, when examined, but a name without signification; unintelligible, if not self-contradictory; at the best, differing in nothing from the "essential forms" of the Greek philosophy? One short sentence of Buffon's work exhibits his scheme as follows: "When this nutritious and prolific matter, which is diffused throughout all nature, passes through the *internal mould* of an animal or vegetable, and finds a proper matrix, or receptacle, it gives rise to an animal or vegetable of the same species." Does any reader annex a meaning to the expression "internal mould," in this sentence? Ought it then to be said, that, though we have little notion of an internal mould, we have not much more of a designing mind? The very contrary of this assertion is the truth. When we speak of an artificer or an architect, we talk of what is comprehensible to our understanding, and familiar to our experience. We use no other terms, than what refer us for their meaning to our consciousness and observation; what express the constant objects of both: whereas names like that we have mentioned, refer us to nothing; excite no idea; convey a sound to the ear, but I think do no more.

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* I trust I may be excused for not citing, as another fact which is to confirm the hypothesis, a grave assertion of this writer, that the branches of trees upon which the stag feeds, break out again in his horns. Such *facts* merit no discussion.—(*Note of the Author.*)

Another system, which has lately been brought forward, and with much ingenuity, is that of *appetencies*. The principle, and the short account of the theory, is this: Pieces of soft, ductile matter, being endued with propensities or appetencies for particular actions, would, by continual endeavors, carried on through a long series of generations, work themselves gradually into suitable forms; and, at length, acquire, though perhaps by obscure and almost imperceptible improvements, an organization fitted to the action which their respective propensities led them to exert. A piece of animated matter, for example, that was endued with a propensity to *fly*, though ever so shapeless, though no other, we will suppose, than a round ball to begin with, would, in a course of ages, if not in a million of years, perhaps in a hundred millions of years, (for our theorists, having eternity to dispose of, are never sparing in time,) acquire *wings*. The same tendency to locomotion in an aquatic animal, or rather in an animated lump, which might happen to be surrounded by water, would end in the production of *fins*; in a living substance, confined to the solid earth, would put out *legs* and *feet*; or, if it took a different turn, would break the body into ringlets, and conclude by *crawling* upon the ground.

Although I have introduced the mention of this theory into this place, I am unwilling to give to it the name of an *atheistic* scheme, for two reasons: first, because, so far as I am able to understand it, the original propensities and the numberless varieties of them, (so different, in this respect, from the laws of mechanical nature, which are few and simple,) are, in the plan itself, attributed to the ordination and appointment of an intelligent and designing Creator: secondly, because, likewise, that large postulatum, which is all along assumed and presupposed, the faculty in living bodies of producing other bodies organized like themselves, seems to be referred to the same cause; at least, is not attempted to be accounted for by any other. In one important respect, however, the theory before us coincides with atheistic systems, *viz.*, in that, in the formation of plants and animals, in the structure and use of their parts, it does away final causes. Instead of the parts of a plant or animal, or the particular structure of the parts, having been intended for the action or the use to which we see them applied; according to this theory, they have themselves grown out of that action, sprung from that use. The theory therefore dispenses with that which we insist upon, the necessity, in each particular case, of an intelligent, designing mind, for the contriving and determining of the forms which organized bodies bear. Give our philosopher these appetencies; give him a portion of living irritable matter, (a nerve, or the clipping of a nerve,) to work upon: give also to his incipient or progressive forms the power, in every stage, of their alteration, of propagating their like: and, if he is to be believed, he could replenish the world with all the vegetable and animal productions which we at present see in it.

The scheme under consideration is open to the same objection with other conjectures of a similar tendency, *viz.*, a total defect of evidence. No changes, like those which the theory requires, have ever been observed. All the changes in Ovid's Metamorphoses might have been effected by these appetencies, if the theory were true; yet not an example, nor the pretence of an example, is offered of a single change being known to have taken place. Nor is the order of reproduction obedient to the principle upon which this theory is built. The mammæ* of the male have not vanished by inusitation. It is easy to say, and it has been said, that the alternative process is too slow to be perceived; that it has been carried on through tracts of immeasurable time;

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* I confess myself totally at a loss to guess at the reason, either final or efficient, for this part of the animal frame: unless there be some foundation for an opinion, of which I draw the hint from a paper of Mr. Everard Home, (Phil. Transact. 1799, Pt. 2,) viz., that the mammæ of the fœtus may be formed before the sex is determined.—(*Note of the Author.*)

and that the present order of things is the result of a graduation, of which no human records can trace the steps. It is easy to say this ; and yet it is still true, that the hypothesis remains destitute of evidence.

The *analogies* which have been alleged, are of the following kind : The *bunch* of a camel is said to be no other than the effect of carrying burdens ; a service in which the species has been employed from the most ancient times of the world. The first race, by the daily loading of the back, would probably find a small grumous tumor to be formed in the flesh of that part. The next progeny would bring this tumor into the world with them. The life to which they were destined would increase it. The cause which first generated the tubercle being continued, it would go on, through every succession, to augment its size, till it attained the form and the bulk under which it now appears. This may serve for one instance ; another, and that also of the passive sort, is taken from certain species of birds. Birds of the *crane* kind, as the crane itself, the heron, bittern, stork, have, in general, their thighs bare of feathers. This privation is accounted for from the habit of wading in water, and from the effect of that element to check the growth of feathers upon these parts ; in consequence of which, the health and vegetation of the feathers declined through each generation of the animal ; the tender down, exposed to cold and wetness, became weak, and thin, and rare, till the deterioration ended in the result which we see, of absolute nakedness. I will mention a third instance, because it is drawn from an active habit, as the two last were from passive habits ; and that is the *pouch* of the pelican. The description which naturalists give of this organ is as follows : "From the lower edges of the under chap, hangs a bag, reaching from the whole length of the bill to the neck, which is said to be capable of containing fifteen quarts of water. This bag the bird has a power of wrinkling up, into the hollow of the under chap. When the bag is empty, it is not seen : but when the bird has fished with success, it is incredible to what an extent it is often dilated. The first thing the pelican does in fishing is to fill the bag; and then it returns to digest its burden at leisure. The bird preys upon the large fishes, and hides them by dozens in its pouch. When the bill is opened to its widest extent, a person may run his head into the bird's mouth; and conceal it in this monstrous pouch, thus adapted for very singular purposes."* Now this extraordinary conformation is nothing more, say our philosophers, than the result of habit; not of the habit or effort of a single pelican, or of a single race of pelicans, but of a habit perpetuated through a long series of generations. The pelican soon found the conveniency of reserving in its mouth, when its appetite was glutted, the remainder of its prey, which is fish. The fulness produced by this attempt, of course stretched the skin which lies between the under chaps, as being the most yielding part of the mouth. Every distension increased the cavity. The original bird, and many generations which succeeded him, might find difficulty enough in making the pouch answer this purpose: but future pelicans, entering upon life with a pouch derived from their progenitors, of considerable capacity, would more readily accelerate its advance to perfection, by frequently pressing down the sac with the weight of fish which it might now be made to contain.

These, or of this kind, are the analogies relied upon. Now, in the first place, the instances themselves are unauthenticated by testimony; and in theory, to say the least of them, open to great objections. Who ever read of camels without bunches, or with bunches less than those with which they are at present usually formed? A bunch not unlike the camel's, is found between the shoulders of the buffalo; of the origin of which it is impossible to give the account here given. In the second example: Why should the application of water, which appears to promote and thicken the growth of feathers upon the bodies and breasts of geese, and swans, and other waterfowls, have divested of this covering the thighs of cranes? The third instance, which appears to me as plausible as any that can be produced, has this against it, that it is a singularity restricted to the species; whereas, if it ha commencement in the cause and manner which have assigned, the like conformation might be expected to ta place in other birds, which fed upon fish. How com it to pass, that the pelican alone was the inventress, an her descendants the only inheritors, of this curious resource?[89]

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* Goldsmith, vol. vi. p. 52.

But it is the less necessary to controvert the instances themselves, as it is a straining of analogy beyond all limits of reason and credibility, to assert that birds, and beasts, and fish, with all their variety and complexity of organision, have been brought into their forms, and distinguished into their several kinds and natures, by the same process (even if that process could be demonstrated, or had it ever been actually noticed) as might seem to serve for the gradual generation of a camel's bunch, or a pelican's pouch.

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[89] The argument against the doctrine of *appetencies* may be urged thus upon wellknown facts. If the camel's bunch has arisen from the animal, originally without any protuberance, having his back affected by burdens imposed, it would follow that human contrivance could alter the shape of beasts; which it most certainly cannot, as daily experience in regard to most domestic animals shows. No change of form produced immediately and directly, as by cutting, compressing, rubbing, can be perpetuated in the breed. All we can do with regard to animals, and all that any animals can do with regard to themselves, is indirectly, as by affecting their health, to affect the proportions of their parts, as bone, fat, muscle; the effects of which changes will be perceived in the progeny.

We have here been observing only upon the fact; but suppose the fact to be as the theory of appetencies assumes;—suppose the camel's bunch has been formed by weight and friction, and the pelican's pouch by the food distending the under chap;—in other words, suppose (contrary to what we have shown is the fact,) that the changes induced in one animal or race at a given time, are propagated and continue in their descendants,—it is plain, that the skeptical argument gains nothing by this concession. For how are such changes continued? Only by the process of generation. Nay, how are they at first effected? By the operation of physical laws,—that is, by the constitution of matter. The quadruped's bunch and the bird's pouch, allowing the whole facts to be as the argument assumes it, are both originally formed and propagated afterwards by the means of the qualities with which matter is endowed; and the inference of design is not affected by the step thus added to the process of reasoning. It can manifestly make no difference to that inference, whether we hold that the bird's pouch is provided for its necessities, by a conformation at all times belonging to it according to the constitution of the world, or by one superinduced according to that same constitution. The utmost that the skeptical hypothesis can gain by such concessions as we have been supposing to be made, is that the form of the world was at one time less perfect than it now is. A similar remark arises upon the conjecture of Laplace (in which others have followed him) respecting the original arrangement of the motions and longitudes of Jupiter's three first satellites.—ENG. ED.

The solution, when applied to the works of Nature *generally*, is contradicted by many of the phenomena, and totally inadequate to others. The *ligaments* or strictures, by which the tendons are tied down at the angles of the joints, could, by no possibility, be formed by the motion or exercise of the tendons themselves; by an appetency exciting these parts into action; or by any tendency arising therefrom. The tendency is all the other way; the *conatus* in constant opposition to them. Length of time does not help the case at all, but the reverse. The *valves* also, in the blood-vessels, could never be formed in the manner which our theorist proposes. The blood, in its right and natural course, has no tendency to form them. When obstructed or refluent, it has the contrary. These parts could not grow out of their use, though they had eternity to grow in.

The *senses* of animals, appear to me altogether incapable of receiving the explanation of their origin which this theory affords. Including under the word "sense" the organ and the perception, we have no account of either. How will our philosopher get at *vision*, or make an eye? How should the blind animal affect sight, of which, blind animals, we know, have neither conception nor desire? Affecting it, by what operation of its will, by what endeavor to see, could it so determine the fluids of its body, as to inchoate the formation of an eye? or suppose the eye formed, would the perception follow? The same of the other senses. And this objection holds its force, ascribe what you will to the hand of time, to the power of habit, to changes too slow to be observed by man, or brought within any comparison which he is able to make of past things with the present; concede what you please to these arbitrary and unattested suppositions, how will they help you? Here is no inception. No laws, no course, no powers of Nature which prevail at present, nor any analogous to these, would give commencement to a new sense. And it is in vain to inquire how that might proceed, which could never *begin.*

I think the senses to be the most inconsistent with the hypothesis before us, of any part of the animal frame. But other parts are sufficiently so. The solution does not apply to the parts of animals, which have little in them of motion. If we could suppose joints and muscles to be gradually formed by action and exercise, what action or exercise could form a scull, and fill it with brains? No effort of the animal could determine the clothing of its skin. What *conatus* could give prickles to the porcupine or hedgehog, or to the sheep its fleece?

In the last place: What do these appetencies mean when applied to plants? I am not able to give a signification to the term, which can be transferred from animals to plants; or which is common to both. Yet a no less successful organization is found in plants, than what obtains in animals. A solution is wanted for one, as well as the other.

Upon the whole, after all the schemes and struggles of a reluctant philosophy, the necessary resort is to a Deity. The marks of *design* are too strong to be gotten over. Design must have had a designer. That designer must have been a person. That person is GOD.

CHAPTER XXIV.

OF THE NATURAL ATTRIBUTES OF THE DEITY.

IT is an immense conclusion, that there is a GOD; a perceiving, intelligent, designing Being; at the head of creation, and from whose will it proceeded. The *attributes* of such a Being, suppose his reality to be proved, must be adequate to the magnitude, extent, and multiplicity of his operations: which are not only vast beyond comparison with those performed by any other power; but, so far as respects our conceptions of them, infinite, because they are unlimited on all sides.

Yet the contemplation of a nature so exalted, however surely we arrive at the proof of its existence, overwhelms our faculties. The mind feels its powers sink under the subject. One consequence of which is, that from painful abstraction the thoughts seek relief in sensible images. Whence may be deduced the ancient, and almost universal propensity to idolatrous substitutions. They are the resources of a laboring imagination. False religions usually fall in with the natural propensity; true religions, or such as have derived themselves from the true, resist it.

It is one of the advantages of the revelations which we acknowledge, that, whilst they reject idolatry with its many pernicious accompaniments, they introduce the Deity to human apprehension, under an idea more personal, more determinate, more within its compass, than the theology of Nature can do. And this they do, by representing Him exclusively under the relation in which He stands to ourselves; and, for the most part, under some precise character, resulting from that relation, or from the history of his providences: which method suits the span of our intellects much better, than the universality which enters into the idea of God, as deduced from the views of Nature. When, therefore, these representations are well-founded in point of authority, (for all depends upon that,) they afford a condescension to the state of our faculties, of which they, who have most reflected on the subject, will be the first to acknowledge the want and the value.

Nevertheless, if we be careful to imitate the documents of our religion, by confining our explanations to what concerns ourselves, and do not affect more precision in our ideas than the subject allows of, the several terms which are employed to denote the attributes of the Deity may be made, even in natural religion, to bear a sense consistent with truth and reason, and not surpassing our comprehension.

These terms are,—Omnipotence, omniscience, omnipresence, eternity, self-existence, necessary existence, spirituality.

"Omnipotence," "omniscience," "infinite" power, "infinite" knowledge, are *superlatives;* expressing our conception of these attributes in the strongest and most elevated terms which language supplies. We ascribe power to the Deity under the name of "omnipotence," the strict and correct conclusion being, that a power which could create such a world as this is, must be, beyond all comparison, greater than any which we experience in ourselves, than any which we observe in other visible agents; greater also than any which we can want, for our individual protection and preservation, in the Being upon whom we depend. It is a power, likewise, to which we are not authorized, by our observation or knowledge, to assign any limits of space or duration.

Very much of the same sort of remark is applicable to the term "omniscience," infinite knowledge, or infinite wisdom. In strictness of language, there is a difference between knowledge and wisdom; wisdom always supposing action, and action directed by it. With respect to the first, viz., *knowledge*, the Creator must know, intimately, the constitution and properties of the things which He created: which seems also to imply a foreknowledge of their action upon one another, and of their changes; at least, so far as the same result from trains of physical and necessary causes. His omniscience also, as far as respects things present, is deducible from his nature, as an intelligent Being, joined with the extent, or rather the universality, of his operations. Where He acts, He is: and where He is, He perceives. The *wisdom* of the Deity, as testified in the works of creation, surpasses all idea we have of wisdom, drawn from the highest intellectual operations of the highest class of intelligent beings with whom we are acquainted; and, which is of the chief importance to us, whatever be its compass or extent, which it is evidently impossible that we should be able to determine, it must be adequate to the conduct of that order of things under which we live. And this is enough. It is of very inferior consequence, by what terms we express our notion, or rather our admiration, of this attribute. The terms, which the piety and the usage of language have rendered habitual to us, may be as proper as any other. We can trace this attribute much beyond what is necessary for any conclusion to which we have occasion to apply it. The degree of knowledge and power requisite for the formation of created nature cannot, with respect to us, be distinguished from infinite.[90]

The Divine "omnipresence" stands, in natural theology, upon this foundation:—In every part and place of the universe with which we are acquainted, we perceive the exertion of a power, which we believe, mediately or immediately, to proceed from the Deity. For instance: in what part or point of space, that has ever been explored, do we not discover attraction? In what regions do we not find light? In what accessible portion of our globe do we not meet with gravity, magnetism, electricity: together with the properties also and powers of organized substances, of vegetable or of animated nature? Nay, further, we may ask, What kingdom is there of nature, what corner of space, in which there is any thing that can be examined by us, where we do not fall upon contrivance and design? The only reflection, perhaps, which arises in our minds from this view of the world around us is, that the laws of Nature every where prevail; that they are uniform and universal. But what do you mean by the laws of Nature, or by any law? Effects are produced by power, not by laws. A law cannot execute itself. A law refers us to an agent. Now an agency so general, as that we cannot discover its absence, or assign the place in which some effect of its continued energy is not found, may, in popular language at least, and, perhaps, without much deviation from philosophical strictness, be called universal: and, with not quite the same, but with no inconsiderable propriety, the person, or Being, in whom that power resides, or from whom it is derived, may be taken to be *omnipresent*. He who upholds all things by his power, may be said to be every where present.

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[90] It is not perhaps quite correct to state, that "*infinite*," as applied to the Deity, means only a degree of power or wisdom beyond all comparison greater than any such qualities possessed by ourselves; and that this term, as well as "*omnipotence*," is merely a superlative. Those words also designate the existence of the attributes in such a degree, that any extent whatever of them being either presented to our observation, or conceived by our imagination, the Deity possesses them in a still greater degree—a degree to which our conception can affix no bounds.

This is called a virtual presence. There is also what metaphysicians denominate an essential ubiquity; and which idea the language of Scripture seems to favor; but the former, I think, goes as far as natural theology carries us.

"Eternity" is a negative idea, clothed with a positive name. It supposes, in that to which it is applied, a present existence; and is the negation of a beginning or an end of that existence. As applied to the Deity, it has not been controverted by those who acknowledge a Deity at all. Most assuredly, there never was a time in which nothing existed, because that condition must have continued. The universal *blank* must have remained; nothing could rise up out of it; nothing could ever have existed since; nothing could exist now. In strictness, however, we have no concern with duration prior to that of the visible world. Upon this article therefore of theology, it is sufficient to know, that the contriver necessarily existed before the contrivance.

"Self-existence" is another negative idea, viz. the negation of a preceding cause, as well as of a progenitor, a maker, an author, a creator.[91]

"Necessary existence" means demonstrable existence.[92]

"Spirituality" expresses an idea, made up of a negative part, and of a positive part. The negative part consists in the exclusion of some of the known properties of matter, especially of solidity, of the *vis inertiæ*, and of gravitation. The positive part comprises perception, thought, will, power, *action*, by which last term is meant the origination of motion; the quality, perhaps, in which resides the essential superiority of spirit over matter, "which cannot move, unless it be moved; and cannot but move, when impelled by another."* I apprehend that there can be no difficulty in applying to the Deity both parts of this idea.

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[91] *Self-existent* means, in any intelligible sense, only uncreated, independent, eternal. The ancient doctrine of *self-created*, if it goes beyond the mere negative sense, is absolutely unintelligible, or, to use Dr. Clarke's words, "an express contradiction."

[92] *Necessary*, properly means demonstrable in such a way, that the contrary involves a contradiction and is inconceivable. Dr. Paley here uses the word demonstrable *per se* in this sense; for which he has the authority of several metaphysical writers.

CHAPTER XXV.

OF THE UNITY OF THE DEITY.

Of the "Unity of the Deity," the proof is, the *uniformity* of plan observable in the universe. The universe itself is a system; each part either depending upon other parts, or being connected with other parts by some common law of motion, or by the presence of some common substance. One principle of gravitation causes a stone to drop towards the earth, and the moon to wheel round it. One law of attraction carries all the different planets about the sun. This philosophers demonstrate. There are also other points of agreement amongst them, which may be considered as marks of the identity of their origin, and of their intelligent Author. In all are found the conveniency and stability derived from gravitation. They all experience vicissitudes of days and nights, and changes of season. They all, at least Jupiter, Mars, and Venus, have the same advantages from their atmosphere as we have. In all the planets, the axes of rotation are permanent. Nothing is more probable, than that the same attracting influence, acting according to the same rule, reaches to the fixed stars: but, if this be only probable, another thing is certain, *viz.*, that the same element of light does. The light from a fixed star affects our eyes in the same manner, is refracted and reflected according to the same laws, as the light of a candle. The velocity of the light of the fixed stars, is also the same as the velocity of the light of the sun, reflected from the satellites of Jupiter. The heat of the sun, in kind, differs nothing from the heat of a coal fire.[93]

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* Bishop Wilkins's Principles of Natural Religion, p. 106.

In our own globe, the case is clearer. New countries are continually discovered, but the old laws of Nature are always found in them: new plants, perhaps, or animals; but always in company with plants and animals which we already know; and always possessing many of the same general properties. We never get amongst such original, or totally different, modes of existence, as to indicate, that we are come into the province of a different Creator, or under the direction of a different will. In truth, the same order of things attends us, wherever we go. The

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[93] The law by which the distances of the planets are regulated, was referred to in a note, by Bishop Brinkley, to the 22d chapter, and affords an evidence of unity of design not to be passed over. It is this nearly, but not exactly. Form a series of numbers, each consisting of the number 4 added to the number 3, but to the number 3 multiplied successively by 0, 1, 2, 4, 8, 16, and the other powers of 2: the mean distance of Mercury being 4, this series will represent the mean distances of the other planets successively. Taking the four newly-discovered planets between Mars and Jupiter as one, the distances of Venus, the Earth, and Jupiter, coincide with the series exactly; the others slightly differ. Thus

Mercury by the supposition	4	4
Venus by the theory	7	by observation 7
Earth	10	10
Mars	16	15
New planets	28	27
Vesta	23·73	
Juno	26·67	
Ceres	27·67	
Pallas	27·68	
Jupiter	52	52
Saturn	100	95
Uranus	196	192

"We cannot but remark," says Bishop Brinkley, "the near agreement of the law with the exact mean distances, and cannot hesitate to pronounce that those were assigned according to a law, although we are entirely ignorant of the exact law and of the reason for that law."

This sentence derives a peculiar, though a painful interest, from the circumstance of its being in all likelihood the last written by this profound and accomplished astronomer, on subjects connected with his favorite study. It closed the communication received from him, which was dated at Cloyne, June 25, 1835; and he died at Dublin, in less than three months after, (September 14.)—Eng. Ed.

elements act upon one another, electricity operates, the tides rise and fall, the magnetic needle elects its position, in one region of the earth and sea, as well as in another. One atmosphere invests all parts of the globe, and connects all; one sun illuminates, one moon exerts its specific attraction upon all parts. If there be a variety in natural effects, as, *e. g.*, in the tides of different seas, that very variety is the result of the same cause, acting under different circumstances. In many cases, this is proved; in all, is probable.

The inspection and comparison of *living* forms add to this argument examples without number. Of all large terrestrial animals, the structure is very much alike; their senses nearly the same; their natural functions and passions nearly the same; their viscera nearly the same, both in substance, shape, and office: digestion, nutrition, circulation, secretion, go on, in a similar manner, in all; the great circulating fluid is the same; for, I think, no difference has been discovered in the properties of *blood*, from whatever animal it be drawn. The experiment of transfusion proves, that the blood of one animal will serve for another. The *skeletons* also of the larger terrestrial animals show particular varieties, but still under a great general affinity. The resemblance is somewhat less, yet sufficiently evident, between quadrupeds and birds. They are all alike in five respects, for one in which they differ.

In *fish*, which belong to another department, as it were, of nature, the points of comparison become fewer. But we never lose sight of our analogy, *e. g.*, we still meet with a stomach, a liver, a spine; with bile and blood; with teeth; with eyes, (which eyes are only slightly varied from our own, and which variation, in truth, demonstrates, not an interruption, but a continuance of the same exquisite plan; for it is the adaptation of the organ to the element, *viz.*, to the different refraction of light passing into the eye out of a denser medium.) The provinces, also, themselves, of water and earth, are connected by the species of animals which inhabit both; and also by a large tribe of aquatic animals, which closely resemble the terrestrial in their internal structure; I mean the cetaceous tribe, which have hot blood, respiring lungs, bowels, and other essential parts, like those of land animals. This similitude, surely, bespeaks the same creation and the same Creator.

Insects and *shellfish* appear to me to differ from other classes of animals the most widely of any. Yet even here, besides many points of particular resemblance, there exists a general relation of a peculiar kind. It is the relation of inversion; the law of contrariety: namely, that, whereas in other animals, the bones, to which the muscles are attached, lie *within* the body, in insects and shellfish they lie on the *outside* of it. The shell of a lobster performs to the animal the office of a *bone*, by furnishing to the tendons that fixed basis or immovable fulcrum, without which, mechanically, they could not act. The crust of an insect is its shell, and answers the like purpose. The shell also of an oyster stands in the place of a *bone;* the bases of the muscles being fixed to it in the same manner as in other animals they are fixed to the bones. All which (under wonderful varieties, indeed, and adaptations of form) confesses an imitation, a remembrance, a carrying on, of the same plan.

The observations here made are equally applicable to plants; but, I think, unnecessary to be pursued. It is a very striking circumstance, and also sufficient to prove all which we contend for, that, in this part likewise of organized nature, we perceive a continuation of the *sexual* system.

Certain however it is, that the whole argument for the Divine unity goes no further than to a unity of counsel.[94]

It may likewise be acknowledged, that no arguments which we are in possession of, exclude the ministry of subordinate agents. If such there be, they act under a presiding, a controlling will; because they act according to certain general restrictions, by certain common rules, and, as it should seem, upon a general plan: but still such agents, and different ranks, and classes, and degrees of them, may be employed.

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[94] The extraordinary discoveries in geology made since Dr. Paley's time by the study of fossil osteology, by no means impair his argument as to unity, when rightly considered. These will be fully discussed in the Appendix, and they throw material light upon other branches of the subject.—ENG. ED.

CHAPTER XXVI.

OF THE GOODNESS OF THE DEITY.

THE proof of the *Divine goodness* rests upon two propositions: each, as we contend, capable of being made out by observations drawn from the appearances of Nature.

The first is, "that, in a vast plurality of instances in which contrivance is perceived, the design of the contrivance is *beneficial.*"

The second, "that the Deity has superadded *pleasure* to animal sensations, beyond what was necessary for any other purpose; or when the purpose, so far as it was necessary, might have been effected by the operation of pain."

First, "in a vast plurality of instances in which contrivance is perceived, the design of the contrivance is *beneficial.*"

No productions of Nature display contrivance so manifestly as the parts of animals; and the parts of animals have all of them, I believe, a real, and, with very few exceptions, all of them a known and intelligible subserviency to the use of the animal. Now when the multitude of animals is considered, the number of parts in each, their figure and fitness, the faculties depending upon them, the variety of species, the complexity of structure, the success, in so many cases, and felicity of the result, we can never reflect, without the profoundest adoration, upon the character of that Being, from whom all these things have proceeded: we cannot help acknowledging what an exertion of benevolence creation was; of a benevolence how minute in its care, how vast in its comprehension!

When we appeal to the parts and faculties of animals, and to the limbs and senses of animals in particular, we state, I conceive, the proper medium of proof for the conclusion which we wish to establish. I will not say.

that the insensible parts of nature are made solely for the sensitive parts: but this I say, that, when we consider the benevolence of the Deity, we can only consider it in relation to sensitive being. Without this reference, or referred to any thing else, the attribute has no object; the term has no meaning. Dead matter is nothing. The parts, therefore, especially the limbs and senses, of animals, although they constitute, in mass and quantity, a small portion of the material creation, yet, since they alone are instruments of perception, they compose what may be called the whole of visible nature, estimated with a view to the disposition of its Author. Consequently, it is in *these* that we are to seek his character. It is by these that we are to prove, that the world was made with a benevolent design.

Nor is the design abortive. It is a happy world after all. The air, the earth, the water, teem with delighted existence. In a spring noon, or a summer evening, on whichever side I turn my eyes, myriads of happy beings crowd upon my view. "The insect youth are on the wing." Swarms of new-born *flies* are trying their pinions in the air. Their sportive motions, their wanton mazes, their gratuitous activity, their continual change of place without use or purpose, testify their joy, and the exultation which they feel in their lately-discovered faculties. A *bee* amongst the flowers in spring, is one of the most cheerful objects that can be looked upon. Its life appears to be all enjoyment; so busy, and so pleased; yet it is only a specimen of insect life, with which, by reason of the animal being half domesticated, we happen to be better acquainted than we are with that of others. The *whole winged* insect tribe, it is probable, are equally intent upon their proper employments, and, under every variety of constitution, gratified, and perhaps equally gratified, by the offices which the Author of their nature has assigned to them. But the atmosphere is not the only scene of enjoyment for the insect race. Plants are covered with aphides, greedily sucking their juices, and constantly, as it should seem, in the act of sucking. It cannot be doubted but that *this is a state* of gratification. What else should fix them so close to the operation, and so long? Other species are *running about*, with an alacrity in their motions which carries with it every mark of pleasure. Large patches of ground are sometimes half covered with these brisk and sprightly natures. If we look to what the *waters* produce, shoals of the fry of fish frequent the margins of rivers, of lakes, and of the sea itself. These are so happy, that they know not what to do with themselves. Their attitudes, their vivacity, their leaps out of the water, their frolics in it, (which I have noticed a thousand times with equal attention and amusement,) all conduce to show their excess of spirits, and are simply the effects of that excess. Walking by the sea-side in a calm evening, upon a sandy shore, and with an ebbing tide, I have frequently remarked the appearance of a dark cloud, or, rather, very thick mist, hanging over the edge of the water, to the height, perhaps, of half a yard, and of the breadth of two or three yards, stretching along the coast as far as the eye could reach, and always retiring with the water. When this cloud came to be examined, it proved to be nothing else than so much space filled with young *shrimps*, in the act of bounding into the air from the shallow margin of the water, or from the wet sand. If any motion of a mute animal could express delight, it was this: if they had meant to make signs of their happiness, they could not have done it more intelligibly. Suppose, then, what I have no doubt of, each individual of this number to be in a state of positive enjoyment; what a sum, collectively, of gratification and pleasure have we here before our view![95]

The *young* of all animals appear to me to receive pleasure simply from the exercise of their limbs and bodily faculties, without reference to any end to be attained, or any use to be answered by the exertion. A child, without knowing any thing of the use of language, is in a high degree delighted with being able to speak. Its incessant repetition of a few articulate sounds, or, perhaps, of the single word which it has learnt to pronounce, proves this point clearly. Nor is it less pleased with its first successful endeavors to walk, or rather to run, (which precedes walking,) although entirely ignorant of the importance of the attainment to its future life, and even without applying it to any present purpose. A child is delighted with speaking, without having any thing to say, and with walking, without knowing where to go. And prior to both these, I am disposed to believe, that the waking hours of infancy are agreeably taken up with the exercise of vision, or perhaps, more properly speaking, with learning to see.

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[95] To these considerations it must be added, that the lives of such animals may be only apparently short. If time is but the succession of ideas, then, as Soame Jenyns has observed, the insect that flutters for a single summer's day, may in reality live as long as the tortoise that breathes for a century.—ENG. ED.

But it is not for youth alone, that the great Parent of creation hath provided. Happiness is found with the purring cat, no less than with the playful kitten ; in the arm-chair of dozing age, as well as in either the sprightliness of the dance, or the animation of the chase. To novelty, to acuteness of sensation, to hope, to ardor of pursuit, succeeds, what is, in no inconsiderable degree, an equivalent for them all, "perception of ease." Herein is the exact difference between the young and the old. The young are not happy but when enjoying pleasure ; the old are happy when free from pain. And this constitution suits with the degrees of animal power which they respectively possess. The vigor of youth was to be stimulated to action by impatience of rest ; whilst, to the imbecility of age, quietness and repose become positive gratifications. In one important respect the advantage is with the old. A state of ease is, generally speaking, more attainable than a state of pleasure. A constitution, therefore, which can enjoy ease, is preferable to that which can taste only pleasure. This same perception of ease oftentimes renders old age a condition of great comfort ; especially when riding at its anchor, after a busy or tempestuous life. It is well described by Rousseau, to be the interval of repose and enjoyment, between the hurry and the end of life. How far the same cause extends to other animal natures, cannot be judged of with certainty. The appearance of satisfaction with which most animals, as their activity subsides, seek and enjoy rest, affords reason to believe, that this source of gratification is appointed to advanced life, under all, or most, of its various forms. In the species with which we are best acquainted, namely, our own, I am far, even as an observer of human life, from thinking that youth is its happiest season, much less the only happy one ; as a Christian, I am willing to believe, that there is a great deal of truth in the following representation, given by a very pious writer, as well as excellent man :* " To the intelligent and virtuous, old age presents a scene of tranquil enjoyments, of obedient appetite, of well-regulated affections, of maturity in knowledge, and of calm preparation for immortality. In this serene and dignified state, placed as it were on the confines of two worlds, the mind of a good man reviews what is past with the complacency of an approving conscience ; and looks forward, with humble confidence in the mercy of God, and with devout aspirations towards his eternal and ever-increasing favor."

What is seen in different stages of the same life, is still more exemplified in the lives of different animals. Animal enjoyments are infinitely *diversified*. The modes of life, to which the organization of different animals respectively determines them, are not only of various but of opposite kinds. Yet each is happy in its own. For instance : animals of prey live much alone ; animals of a milder constitution, in society. Yet the herring, which live in shoals, and the sheep, which live in flocks, are not more happy in a crowd, or more contented amongst their companions, than is the pike, or the lion, with the deep solitudes of the pool, or the forest.

But it will be said, that the instances which we have here brought forward, whether of vivacity or repose, or of apparent enjoyment derived from either, are picked and favorable instances. We answer, first, that they are instances, nevertheless, which comprise large provinces of sensitive existence ; that every case which we have described is the case of millions. At this moment, in every given moment of time, how many myriads of animals are eating their food, gratifying their appetites, ruminating in their holes, accomplishing their wishes, pursuing their pleasures, taking their pastimes! In each individual, how many things must go right for it to be at ease; yet how large a proportion out of every species is so, in every assignable instant! Secondly, we contend, in the terms of our original proposition, that throughout the whole of life, as it is diffused in nature, and as far as we are acquainted with it, looking to the average of sensations, the plurality and the preponderancy is in favor of happiness by a vast excess. In our own species, in which perhaps the assertion may be more questionable than any other, the prepollency of good over evil, of health, for example, and ease, over pain and distress, is evinced by the very notice which calamities excite. What inquiries does the sickness of our friends produce! what conversation their misfortunes! This shows that the common course of things is in favor of happiness; that happiness is the rule, misery the exception. Were the order reversed, our attention would be called to examples of health and competency, instead of disease and want.

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* Father's Instructions ; by Dr. Percival, of Manchester, p. 317.

One great cause of our insensibility to the goodness of the Creator, is the very *extensiveness* of his bounty. We prize but little what we share only in common with the rest, or with the generality of our species. When we hear of blessings, we think forthwith of successes, of prosperous fortunes, of honors, riches, preferments, *i. e.*, of those advantages and superiorities over others, which we happen either to possess, or to be in pursuit of, or to covet. The common benefits of our nature entirely escape us. Yet these are the great things. These constitute what most properly ought to be accounted blessings of Providence; what alone, if we might so speak, are worthy of its care. Nightly rest and daily bread, the ordinary use of our limbs, and senses, and understandings, are gifts which admit of no comparison with any other. Yet because almost every man we meet with possesses these, we leave them out of our enumeration. They raise no sentiment; they move no gratitude. Now, herein is our judgement perverted by our selfishness. A blessing ought in truth to be the *more* satisfactory, the bounty at least of the donor is rendered more conspicuous, by its very diffusion, its commonness, its cheapness; by its falling to the lot, and forming the happiness, of the great bulk and body of our species, as well as of ourselves. Nay, even when we do not possess it, it ought to be matter of thankfulness that others do. But we have a different way of thinking. We court distinction. That is not the worst: we *see* nothing but what has distinction to recommend it. This necessarily contracts our views of the Creator's beneficence within a narrow compass; and most unjustly. It is in those things which are so common as to be no distinction, that the amplitude of the Divine benignity is perceived.

But pain, no doubt, and privations exist, in numerous instances, and to a great degree, which collectively would be very great, if they were compared with any other thing than with the mass of animal fruition. For the application, therefore, of our proposition to that *mixed* state of things which these exceptions induce, two rules are necessary, and both, I think, just and fair rules. One is, that we regard those effects alone which are accompanied with proofs of intention: The other, that when we cannot resolve all appearances into benevolence of design, we make the few give place to the many; the little to the great; that we take our judgement from a large and decided preponderancy, if there be one.[96]

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[96] This passage, with others which afterwards occur in this work, as well as the part here quoted from the author's Moral Philosophy, has been, it should seem, somewhat misunderstood by several excellent authors, who have treated him as if he were denying the existence of evil; and have referred, though without any skeptical view, to the old dilemma of the Epicureans, stated by Lactantius:—"Aut vult, et non potest; aut potest et non vult tollere mala."* But Dr. Paley's whole discourse upon this subject must be taken as an attempt, and a successful one, to diminish the apparent amount of evil, by showing that many of the things accounted evils are less bad than they seem to be. He explains the deductions which are fairly to be made; he shows the compensations which exist; he proves, that out of evil good frequently arises. Having done this, evil still remains, but in an amount exceedingly reduced: and this remaining portion is that concerning which alone the question arises. All that follows of the text must be read with this

* [He either desires, and is not able, to remove evil; or, he is able, and does not desire it.—AM. ED.]

I crave leave to transcribe into this place what I have said upon this subject in my Moral Philosophy :—

"When God created the human species, either He wished their happiness, or He wished their misery, or He was indifferent and unconcerned about either.

"If He had wished our misery, He might have made sure of his purpose, by forming our senses to be so many sores and pains to us, as they are now instruments of gratification and enjoyment ; or by placing us amidst objects so ill suited to our perceptions, as to have continually offended us, instead of ministering to our refreshment and delight. He might have made, for example, every thing we tasted, bitter ; every thing we saw, loathsome ; every thing we touched, a sting ; every smell, a stench ; and every sound, a discord.

"If He had been indifferent about our happiness or misery, we must impute to our good fortune (as all design by this supposition is excluded) both the capacity of our senses to receive pleasure, and the supply of external objects fitted to produce it.

"But either of these, and still more both of them, being too much to be attributed to accident, nothing remains but the first supposition, that God, when He created the human species, wished their happiness ; and made for them the provision which He has made, with that view and for that purpose.

"The same argument may be proposed in different terms ; *thus :* Contrivance proves design ; and the predominant tendency of the contrivance indicates the disposition of the designer. The world abounds with contrivances ; and all the contrivances which we are acquainted with, are directed to beneficial purposes. Evil, no doubt, exists ; but is never, that we can perceive, the *object* of contrivance. Teeth are contrived to eat, not to ache ; their aching now and then, is incidental to the contrivance, perhaps inseparable from it : or even, if you will, let it be called a defect in the contrivance ; but it

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view ; and it must be admitted, that nothing can be more legitimate than the scope of the reasoning employed, if regarded in this light. Viewed in any other, it would be liable to the objections which have been urged against it.—ENG. ED.

is not the object of it. This is a distinction which well deserves to be attended to. In describing implements of husbandry, you would hardly say of the sickle, that it is made to cut the reaper's hand: though from the construction of the instrument, and the manner of using it, this mischief often follows. But if you had occasion to describe instruments of torture, or execution,—this engine, you would say, is to extend the sinews; this to dislocate the joints; this to break the bones; this to scorch the soles of the feet. Here, pain and misery are the very objects of the contrivance. Now, nothing of this sort is to be found in the works of Nature. We never discover a train of contrivance to bring about an evil purpose. No anatomist ever discovered a system of organization, calculated to produce pain and disease; or, in explaining the parts of the human body, ever said, this is to irritate; this to inflame; this duct is to convey the gravel to the kidneys; this gland to secrete the humor which forms the gout: if by chance he come at a part of which he knows not the use, the most he can say is, that it is useless; no one ever suspects that it is put there to incommode, to annoy, or to torment."

The TWO CASES which appear to me to have the most difficulty in them, as forming the most of the appearance of exception to the representation here given, are those of *venomous* animals, and of animals *preying* upon one another. These properties of animals, wherever they are found, must, I think, be referred to design; because there is, in all cases of the first, and in most cases of the second, an express and distinct organization provided for the producing of them. Under the first head, the fangs of vipers, the stings of wasps and scorpions, are as clearly intended for their purpose, as any animal structure is for any purpose the most incontestably beneficial. And the same thing must, under the second head, be acknowledged of the talons and beaks of birds, of the tusks, teeth, and claws of beasts of prey; of the shark's mouth, of the spider's web, and of numberless weapons of offence belonging to different tribes of voracious insects. We cannot, therefore, avoid the difficulty by saying, that the effect was not intended. The only question open to us is, whether it be ultimately evil. From the confessed and felt imperfection of our knowledge, we ought to presume, that there may be consequences of this economy which are hidden from us: from the benevolence which pervades the general designs of Nature, we ought also to presume, that these consequences, if they could enter into our calculation, would turn the balance on the favorable side. Both these I contend to be reasonable presumptions. Not reasonable presumptions, if these two cases were the only cases which Nature presented to our observation; but reasonable presumptions under the reflection, that the cases in question are combined with a multitude of intentions, all proceeding from the same Author, and all, except these, directed to ends of undisputed utility. Of the vindications, however, of this economy, which we are able to assign, such as most extenuate the difficulty are the following.

With respect to *venomous* bites and stings, it may be observed,—

1. That, the animal itself being regarded, the faculty complained of is *good;* being conducive, in all cases, to the defence of the animal; in some cases, to the subduing of its prey; and in some, probably, to the killing of it, when caught, by a mortal wound, inflicted in the passage to the stomach, which may be no less merciful to the victim, than salutary to the devourer. In the viper, for instance, the poisonous fang may do that which, in other animals of prey, is done by the crush of the teeth. Frogs and mice might be swallowed alive without it.

2. But it will be said, that this provision, when it comes to the case of bites, deadly even to human bodies, and to those of large quadrupeds, is greatly *overdone;* that it might have fulfilled its use, and yet have been much less deleterious than it is. Now I believe the case of bites which produce death in large animals (of stings I think there are none) to be very few. The experiments of the Abbé Fontana, which were numerous, go strongly to the proof of this point. He found that it required the action of five exasperated vipers to kill a dog of a moderate size;

but that to the killing of a mouse, or a frog, a single bite was sufficient; which agrees with the use which we assign to the faculty. The Abbé seemed to be of opinion, that the bite even of the rattlesnake, would not usually be mortal; allowing, however, that in certain particularly unfortunate cases, as when the puncture had touched some very tender part, pricked a principal nerve, for instance, or, as it is said, some more considerable lymphatic vessel, death might speedily ensue.

3. It has been, I think, very justly remarked, concerning serpents, that, whilst only a few species possess the venomous property, that property guards the whole tribe. The most innocuous snake is avoided with as much care as a viper. Now the terror with which large animals regard this class of reptiles is its protection; and this terror is founded on the formidable revenge, which a few of the number, compared with the whole, are capable of taking. The species of serpents, described by Linnæus, amount to two hundred and eighteen, of which thirty-two only are poisonous.

4. It seems to me, that animal constitutions are provided, not only for each element, but for each state of the elements, *i. e.*, for every climate, and for every temperature; and that part of the mischief complained of, arises from animals (the human animal most especially) occupying situations upon the earth which do not belong to them, nor were ever intended for their habitation. The folly and wickedness of mankind, and necessities proceeding from these causes, have driven multitudes of the species to seek a refuge amongst burning sands, whilst countries, blessed with hospitable skies, and with the most fertile soils, remain almost without a human tenant. We invade the territories of wild beasts and venomous reptiles, and then complain, that we are infested by their bites and stings. Some accounts of Africa place this observation in a strong point of view. "The deserts," says Adanson, "are entirely barren, except where they are found to produce serpents; and in such quantities, that some extensive plains are almost entirely covered with them." These are the natures appropriated to the situation. Let them

enjoy their existence ; let them have their country. Surface enough will be left to man, though his numbers wer increased a hundred-fold, and left to him, where he r live exempt from these annoyances.

The SECOND CASE, *viz.*, that of animals *devouring* another, furnishes a consideration of much larger exte To judge whether, as a general provision, this can b deemed an *evil*, even so far as we understand its consequences, which, probably, is a partial understanding, th following reflections are fit to be attended to.[97]

I. Immortality upon this earth is out of the question. Without death there could be no generation, no sexes, no parental relation, *i. e.*, as things are constituted, no animal happiness. The particular duration of life, assigned to different animals, can form no part of the objection; because, whatever that duration be, whilst it remains finite and limited, it may always be asked, why it is no longer. The natural age of different animals varies, from a single day to a century of years. No account can be given of this ; nor could any be given, whatever other proportion of life had obtained amongst them.

The term then of life, in different animals, being the same as it is, the question is, what mode of taking it away is the best even for the animal itself.

Now, according to the established order of Nature,

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[97] The subject of apparently conflicting contrivances, including conflicting instincts, as well as apparently imperfect contrivances and instincts, will be considered in a subsequent part of the Work. The progress of science is constantly diminishing the number of such instances, as far as our ignorance of design goes. That some conflict will continue ; in other words, that evil to a certain amount will, after all deductions, be found to exist, cannot be doubted. But that an immense preponderance of good exists in every department of Nature, both of matter and of mind, is so clear, that, arguing as we do on every other subject, we have a right to impute the perception of any evil at all to our own ignorance ; and to conclude that, if we knew the whole system, and could extend our comprehension to the entire plan of creation, we should no longer believe there was evil at all. Of the different hypotheses to which we may have recourse, for explaining what we are unable legitimately to solve, the Probationary State is one, and is the one which appears to tally best with the facts. It is hardly necessary to add, that we are now, as throughout these notes, after the example of the author, confining ourselves altogether to the intimations received from natural reason and observation, unaided by the light of revelation.—ENG. ED.

(which we must suppose to prevail, or we cannot reason at all upon the subject,) the three methods by which life is usually put an end to, are, acute diseases, decay, and violence. The simple and natural life of *brutes* is not often visited by acute distempers; nor could it be deemed an improvement of their lot, if it were. Let it be considered, therefore, in what a condition of suffering and misery a brute animal is placed, which is left to perish by *decay*. In human sickness or infirmity, there is the assistance of man's rational fellow-creatures; if not to alleviate his pains, at least to minister to his necessities; and to supply the place of his own activity. A brute, in his wild and natural state, does every thing for himself. When his strength, therefore, or his speed, or his limbs, or his senses fail him, he is delivered over, either to absolute famine, or to the protracted wretchedness of a life slowly wasted, by the scarcity of food. Is it, then, to see the world filled with drooping, superannuated, half-starved, helpless, and unhelped animals, that you would alter the present system of pursuit and prey?

2. Which system is also, to them, the spring of motion and activity on both sides. The pursuit of its prey forms the employment, and appears to constitute the pleasure, of a considerable part of the animal creation. The using of the means of defence, or flight, or precaution, forms also the business of another part. And even of this latter tribe, we have no reason to suppose, that their happiness is much molested by their fears. Their danger exists continually; and in some cases they seem to be so far sensible of it, as to provide, in the best manner they can, against it; but it is only when the attack is actually made upon them, that they appear to suffer from it. To contemplate the insecurity of their condition with anxiety and dread, requires a degree of reflection which (happily for themselves) they do not possess. A *hare*, notwithstanding the number of its dangers and its enemies, is as playful an animal as any other.

3. But, to do justice to the question, the system of animal *destruction* ought always to be considered in strict connexion with another property of animal nature, viz.,

superfecundity. They are countervailing qualities. One subsists by the correction of the other. In treating, therefore, of the subject under this view, (which is, I believe, the true one,) our business will be, first, to point out the advantages which are gained by the powers in nature of a superabundant multiplication; and then to show, that these advantages are so many reasons for appointing that system of national hostilities, which we are endeavoring to account for.

In almost all cases, Nature produces her supplies with profusion. A single codfish spawns, in one season, a greater number of eggs than all the inhabitants of England amount to. A thousand other instances of prolific generation might be stated, which, though not equal to this, would carry on the increase of the species with a rapidity which outruns calculation, and to an immeasurable extent. The advantages of such a constitution are two: first, that it tends to keep the world always full: whilst, secondly, it allows the proportion between the several species of animals to be differently modified, as different purposes require, or as different situations may afford for them room and food. Where this vast fecundity meets with a vacancy fitted to receive the species, there it operates with its whole effect; there it pours in its numbers and replenishes the waste. We complain of what we call the exorbitant multiplication of some troublesome insects; not reflecting, that large portions of nature might be left void without it. If the accounts of travellers may be depended upon, immense tracts of forests in North America would be nearly lost to sensitive existence, if it were not for *gnats*. "In the thinly inhabited regions of America, in which the waters stagnate and the climate is warm, the whole air is filled with crowds of these insects." Thus it is, that where we looked for solitude and deathlike silence, we meet with animation, activity, enjoyment; with a busy, a happy, and a peopled world. Again; hosts of *mice* are reckoned amongst the plagues of the northeast part of Europe; whereas vast plains in Siberia, as we learn from good authority, would be lifeless without them. The Caspian deserts are converted, by their presence, into crowds of warrens. Between the Volga and the Yaik, and in the country of Hyrcania, the ground, says Pallas, is in many places *covered* with little hills, raised by the earth cast out in forming the burrows. Do we so envy these blissful abodes, as to pronounce the fecundity by which they are supplied with inhabitants to be an evil; a subject of complaint, and not of praise? Further; by virtue of this same superfecundity, what we term destruction becomes, almost instantly, the parent of life. What we call blights, are oftentimes legions of animated beings, claiming their portion in the bounty of Nature. What corrupts the produce of the earth to us, prepares it for them. And it is by means of their rapid multiplication, that they take possession of their pasture; a slow propagation would not meet the opportunity.

But in conjunction with the occasional use of this fruitfulness, we observe, also, that it allows the proportion between the several species of animals to be differently modified, as different purposes of utility may require. When the forests of America come to be cleared, and the swamps drained, our gnats will give place to other inhabitants. If the population of Europe should spread to the north and the east, the mice will retire before the husbandman and the shepherd, and yield their station to herds and flocks. In what concerns the human species, it may be a part of the scheme of Providence, that the earth should be inhabited by a shifting, or perhaps a circulating population. In this economy, it is possible that there may be the following advantages: When old countries are become exceedingly corrupt, simpler modes of life, purer morals, and better institutions, may rise up in new ones; whilst fresh soils reward the cultivator with more plentiful returns. Thus the different portions of the globe come into use, in succession, as the residence of man; and, in his absence, entertain other guests, which, by their sudden multiplication, fill the chasm. In domesticated animals, we find the effect of their fecundity to be, that we can always command *numbers*; we can always have as many of any particular species as we please, or as we can support. Nor do we complain of its excess; it being much more easy to regulate abundance, than to supply scarcity. But then this *superfecundity*, though of great occasional use and importance, exceeds the ordinary capacity ofNature to receive or support its progeny. All superabundance supposes destruction, or must destroy itself. Perhaps there is no species of terrestrial animals whatever, which would not overrun the earth, if it were permitted to multiply in perfect safety; or of fish, which would not fill the ocean: at least, if any single species were left to their natural increase, without disturbance or restraint, the food of other species would be exhausted by their maintenance. It is necessary, therefore, that the effects of such prolific faculties be curtailed. In conjunction with other checks and limits, all subservient to the same purpose, are the *thinnings* which take place among animals, by their action upon one another. In some instances, we ourselves experience, very directly, the use of these hostilities. One species of insects rids us of another species; or reduces their ranks. A third species, perhaps, keeps the second within bounds; and birds or lizards are a fence against the inordinate increase, by which even these last might infest us. In other, more numerous, and possibly more important instances, this disposition of things, although less necessary or useful to us, and of course less observed by us, may be necessary and useful to certain other species; or even for the preventing of the loss of certain species from the universe: a misfortune which seems to be studiously guarded against. Though there may be the appearance of failure in some of the details of Nature's works, in her great purposes there never are. Her species never fail. The provision which was originally made, for continuing the replenishment of the world, has proved itself to be effectual through a long succession of ages.

What further shows, that the system of destruction amongst animals, holds an express relation to the system of fecundity,—that they are parts indeed of one compensatory scheme,—is, that in each species the fecundity bears a proportion to the smallness of the animal, to the weakness, to the shortness of its natural term of life, and to the dangers and enemies by which it is surrounded.

An elephant produces but one calf; a butterfly lays six hundred eggs. Birds of prey seldom produce more than two eggs; the sparrow tribe, and the duck tribe, frequently sit upon a dozen. In the rivers, we meet with a thousand minnows for one pike; in the sea, a million of herrings for a single shark. Compensation obtains throughout. Defencelessness and devastation are repaired by fecundity.

We have dwelt the longer on these considerations, because the subject to which they apply, namely, that of animals *devouring* one another, forms the chief, if not the only instance, in the works of the Deity, of an economy, stamped by marks of design, in which the character of utility can be called in question. The case of *venomous* animals is of much inferior consequence to the case of prey, and, in some degree, is also included under it. To both cases, it is probable that many more reasons belong, than those of which we are in possession.

Our FIRST PROPOSITION, and that which we have hitherto been defending, was, "that, in a vast plurality of instances, in which *contrivance* is perceived, the design of the contrivance is beneficial."

Our SECOND PROPOSITION is, "that the Deity has added *pleasure* to animal sensations, beyond what was necessary for any other purpose, or when the purpose, so far as it was necessary, might have been effected by the operation of pain."[98]

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[98] This is a most important consideration, and one which cannot be dwelt upon too constantly; and which assuredly will, by the contemplative and well-regulated mind, never be dwelt upon without experiencing the most pleasing and salutary influence. It will be further illustrated in the Appendix; but in this place it may be right to add, that the induction of facts plainly shows the system of the universe to be governed upon the principle of inducement, rather than denouncement; of reward more than of punishment; and not only are sentient beings guided by the more kindly process, where the harsher would have sufficed, but there is more inducement employed, more pleasure superadded, than is even necessary to work the effect intended. It is as if a human lawgiver were to prefer rewarding his subjects for obedience, rather than punishing them for contumacy; and were then to add some bounty, beyond what had been found quite sufficient to insure their compliance. It must be constantly borne in mind, that there is not one single act performed by any animal, from man to the *lowest insect in the scale*, in fulfilling the apparent ends of its creation,

This proposition may be thus explained:—The capacities, which, according to the established course of nature, are *necessary* to the support or preservation of an animal, however manifestly they may be the result of an organization contrived for the purpose, can only be deemed an act or a part of the same will, as that which decreed the existence of the animal itself; because, whether the creation proceeded from a benevolent or a malevolent being, these capacities must have been given, if the animal existed at all. Animal properties, therefore, which fall under this description, do not strictly prove the goodness of God; they may prove the existence of the Deity; they may prove a high degree of power and intelligence: but they do not prove his goodness; forasmuch as they must have been found in any creation which was capable of continuance, although it is possible to suppose, that such a creation might have been produced by a being whose views rested upon misery.

But there is a class of properties, which may be said to be superadded from an intention expressly directed to happiness; an intention to give a happy existence, distinct from the general intention of providing the means of existence; and that is, of capacities for pleasure, in cases wherein, so far as the conservation of the individual or of the species is concerned, they were not wanted, or wherein the purpose might have been secured by the operation of pain. The provision which is made of a variety of objects, not necessary to life, and ministering only to our pleasures; and the properties given to the necessaries of life themselves, by which they contribute to pleasure as well as preservation; show a further design than that of giving existence.*

A single instance will make all this clear. Assuming the necessity of food for the support of animal life, it is

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the performance of which might not have been secured as effectually, by the pressure, or by the apprehension of pain, as it now is, in so vast a number of instances, solicited, by the enjoyment or the hope of some gratification.—ENG. ED.

* See this topic considered in Dr. Balguy's Treatise upon the Divine Benevolence. This excellent author first, I think, proposed it; and nearly in the terms in which it is here stated. Some other observations also, under this head, are taken from that treatise.—*Note of the Author.*

requisite that the animal be provided with organs fitted for the procuring, receiving, and digesting of its food. It may also be necessary, that the animal be impelled by its sensations to exert its organs. But the pain of hunger would do all this. Why add pleasure to the act of eating; sweetness and relish to food? why a new and appropriate sense for the perception of the pleasure? Why should the juice of a peach, applied to the palate, affect the part so differently from what it does when rubbed upon the palm of the hand? This is a constitution which, so far as appears to me, can be resolved into nothing but the pure benevolence of the Creator. Eating is necessary; but the pleasure attending it, is not necessary: and that this pleasure depends, not only upon our being in possession of the sense of taste, which is different from every other, but upon a particular state of the organ in which it resides, a felicitous adaptation of the organ to the object, will be confessed by any one, who may happen to have experienced that vitiation of taste which frequently occurs in fevers, when every taste is irregular, and every one bad.

In mentioning the gratifications of the palate, it may be said, that we have made choice of a trifling example.[99] I am not of that opinion. They afford a share of enjoyment to man; but to brutes, I believe that they are of very great importance. A horse at liberty passes a great part of his waking hours in eating. To the ox, the sheep, the deer, and other ruminating animals, the pleasure is doubled. Their whole time, almost, is divided between browsing upon their pasture and chewing their cud. Whatever the pleasure be, it is spread over a large portion of their existence. If there be animals, such as the lupous fish, which swallow their prey whole, and at once, without any time, as it should seem, for either drawing out, or relishing, the taste in the mouth, is it an improbable conjecture, that the seat of taste with them is in the stomach; or, at least, that a sense of pleasure, whether it be taste or not, accompanies the dissolution of the food in that receptacle, which dissolution, in general, is carried on very slowly? If this opinion be right, they are more than repaid for the defect of palate. The feast lasts as long as the digestion.

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[99] Neither this, nor any other thing which our nature, physical or moral, is formed to relish, can be deemed trifling; and it is well observed afterwards, that the very capacity of being pleased with what, by comparison with other things, are termed trivial matters, is itself a source of enjoyment provided for us by the Divine beneficence. All men have, within themselves, the power of being amused or occupied, and interested—that is, pleased, gratified—with things which, until they make the attempt, they are disposed to regard as wholly incapable of affording any satisfaction. This is a most important source of enjoyment, and one more independent of external circumstances, than they could believe who have never made the experiment.—ENG. ED.

In seeking for argument, we need not stay to insist upon the comparative importance of our example; for the observation holds equally of all, or of three at least, of the other senses. The necessary purposes of hearing might have been answered without harmony; of smell, without fragrance; of vision, without beauty. Now, "if the Deity had been indifferent about our happiness or misery, we must impute to our good fortune, (as all design by this supposition is excluded,) both the capacity of our senses to receive pleasure, and the supply of external objects fitted to excite it." I allege these as *two* felicities, for they are different things, yet both necessary: the sense being formed, the objects, which were applied to it, might not have suited it; the objects being fixed, the sense might not have agreed with them. A coincidence is here required, which no accident can account for. There are three possible suppositions upon the subject, and no more. The first; that the sense, by its original constitution, was made to suit the object: The second; that the object, by its original constitution, was made to suit the sense: The third; that the sense is so constituted, as to be able, either universally, or within certain limits, by habit and familiarity, to render every object pleasant. Whichever of these suppositions we adopt, the effect evinces, on the part of the Author of nature, a studious benevolence. If the pleasures which we derive from any of our senses, depend upon an original congruity between the sense and the properties perceived by it, we know by experience that the adjustment demanded, with respect to the qualities which were conferred upon the objects that surround us, not only choice and selection, out of a boundless variety of possible qualities with which these objects might have been endued, but a *proportioning also of degree*; because an excess or defect of intensity spoils the perception, as much almost as an error in the kind and nature of the quality. Likewise, the degree of dulness or acuteness in the sense itself, is no arbitrary thing; but, in order to preserve the congruity here spoken of, requires to be in an exact, or near correspondency, with the strength of the impression. The dulness of the senses forms the complaint of old age. Persons in fevers, and, I believe, in most maniacal cases, experience great torment from their preternatural acuteness. An increased, no less than an impaired sensibility, induces a state of disease and suffering.

The doctrine of a specific congruity, between animal senses and their objects, is strongly favored by what is observed of insects, in the election of their food. Some of these will feed upon one kind of plant or animal, and upon no other: some caterpillars upon the cabbage alone; some upon the black currant alone. The species of caterpillar which eats the vine, will starve upon the alder; nor will that which we find upon fennel touch the rose-bush. Some insects confine themselves to two or three kinds of plants or animals. Some again show so strong a preference, as to afford reason to believe that, though they may be driven by hunger to others, they are led by the pleasure of taste to a few particular plants alone; and all this, as it should seem, independently of habit or imitation.

But should we accept the third hypothesis, and even carry it so far as to ascribe every thing which concerns the question to habit, (as in certain species, the human species most particularly, there is reason to attribute something,) we have then before us an animal capacity, not less perhaps to be admired than the native congruities which the other scheme adopts. It cannot be shown to result from any fixed necessity in Nature, that what is frequently applied to the senses, should of course become agreeable to them. It is, so far as it subsists, a power of accommodation provided in these senses by the Author of their structure, and forms a part of their perfection.

In whichever way we regard the senses, they appear to be specific gifts, ministering, not only to preservation, but to pleasure. But what we usually call the *senses*, are probably themselves far from being the only vehicles of enjoyment, or the whole of our constitution which is calculated for the same purpose. We have many internal sensations of the most agreeable kind, hardly referable to any of the five senses. Some physiologists have holden that all secretion is pleasurable; and that the complacency which in health, without any external assignable object to excite it, we derive from life itself, is the effect of our secretions going on well within us. All this may be true; but if true, what reason can be assigned for it, except the will of the Creator? It may reasonably be asked, Why is any thing a pleasure? and I know no answer which can be returned to the question, but that which refers it to appointment.

We can give no account whatever of our pleasures in the simple and original perception; and, even when physical sensations are assumed, we can seldom account for them in the secondary and complicated shapes in which they take the name of diversions. I never yet met with a sportsman, who could tell me in what the sport consisted; who could resolve it into its principle, and state that principle. I have been a great follower of fishing myself, and in its cheerful solitude have passed some of the happiest hours of a sufficiently happy life; but, to this moment, I could never trace out the source of the pleasure which it afforded me.

The "quantum in rebus inane!"* whether applied to our amusements or to our graver pursuits, (to which, in truth, it sometimes equally belongs,) is always an unjust complaint. If trifles engage, and if trifles make us happy, the true reflection suggested by the experiment, is upon the tendency of Nature to gratification and enjoyment; which is, in other words, the goodness of its Author towards his sensitive creation.

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* [What vanity in all things!—AM. ED.]

Rational natures also, as such, exhibit qualities which help to confirm the truth of our position. The degree of understanding found in mankind, is usually much greater than what is necessary for mere preservation. The pleasure of choosing for themselves, and of prosecuting the object of their choice, should seem to be an original source of enjoyment. The pleasures received from things, great, beautiful, or new; from imitation, or from the liberal arts; are, in some measure, not only superadded, but unmixed, gratifications, having no pains to balance them.*

I do not know whether our attachment to *property*, be not something more than the mere dictate of reason, or even than the mere effect of association. Property communicates a charm to whatever is the object of it. It is the first of our abstract ideas; it cleaves to us the closest and the longest. It endears to the child its plaything, to the peasant his cottage, to the landholder his estate. It supplies the place of prospect and scenery. Instead of coveting the beauty of distant situations, it teaches every man to find it in his own. It gives boldness and grandeur to plains and fens, tinge and coloring to clays and fallows.

All these considerations come in aid of our *second* proposition. The reader will now bear in mind what our two propositions were. They were, firstly, that in a vast plurality of instances, in which contrivance is perceived, the design of the contrivance is beneficial: secondly, that the Deity has added pleasure to animal sensations, beyond what was necessary for any other purpose; or when the purpose, so far as it was necessary, might have been effected by the operation of pain.

Whilst these propositions can be maintained, we are authorized to ascribe to the Deity the character of benevolence; and what is benevolence at all, must in Him be *infinite* benevolence, by reason of the infinite, that is to say, the incalculably great, number of objects upon which it is exercised.

Of the ORIGIN OF EVIL no universal solution has been discovered; I mean, no solution which reaches to all cases of complaint. The most comprehensive, is that which arises from the consideration of ***general rules.*** We may, I think, without much difficulty, be brought to admit the four following points: first, that important advantages may accrue to the universe from the order of Nature proceeding according to general laws: secondly, that general laws, however well set and constituted, often thwart and cross one another: thirdly, that from these thwartings and crossings, frequent particular inconveniencies will arise: and, fourthly, that it agrees with our observation to suppose, that some degree of these inconveniences takes place in the works of Nature. These points may be allowed; and it may also be asserted, that the general laws with which we are acquainted, are directed to beneficial ends. On the other hand, with many of these laws we are not acquainted at all, or we are totally unable to trace them in their branches, and in their operation; the effect of which ignorance is, that they cannot be of importance to us as measures by which to regulate our conduct. The conservation of them may be of importance in other respects, or to other beings, but we are uninformed of their value or use; uninformed consequently, when, and how far, they may or may not be suspended, or their effects turned aside, by a presiding and benevolent will, without incurring greater evils than those which would be avoided. The consideration, therefore, of general laws, although it may concern the question of the origin of evil very nearly, (which I think it does,) rests in views disproportionate to our faculties, and in a knowledge which we do not possess. It serves rather to account for the obscurity of the subject, than to supply us with distinct answers to our difficulties. However, whilst we assent to the above-stated propositions, as principles, whatever uncertainty we may find in the application, we lay a ground for believing, that cases of apparent evil, for which *we* can suggest no particular reason, are governed by reasons, which are more general, which lie deeper in the order of second causes, and which on that account are removed to a greater distance from us.

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* Balguy on the Divine Benevolence.

The doctrine of *imperfections*, or, as it is called, of evils of imperfection, furnishes an account, founded, like the former, in views of universal nature. The doctrine is briefly this :—It is probable, that creation may be better replenished by sensitive beings of different sorts, than by sensitive beings all of one sort. It is likewise probable, that it may be better replenished by different orders of beings, rising one above another in gradation, than by beings possessed of equal degrees of perfection. Now, a gradation of such beings implies a gradation of imperfections. No class can justly complain of the imperfections which belong to its place in the scale, unless it were allowable for it to complain, that a scale of being was appointed in Nature ; for which appointment there appear to be reasons of wisdom and goodness.

In like manner *finiteness*, or what is resolvable into finiteness, in inanimate subjects, can never be a just subject of complaint ; because if it were ever so, it would be always so : we mean, that we can never reasonably demand that things should be larger or more, when the same demand might be made, whatever the quantity or number was.

And to me it seems, that the sense of mankind has so far acquiesced in these reasons, as that we seldom complain of evils of this class, when we clearly perceive them to be such. What I have to add, therefore, is, that we ought not to complain of some other evils, which stand upon the same foot of vindication as evils of confessed imperfection. We never complain, that the globe of our earth is too small : nor should we complain, if it were even much smaller. But where is the difference to us, between a less globe, and part of the present being uninhabitable ? The inhabitants of an island may be apt enough to murmur at the sterility of some parts of it ; against its rocks, or sands, or swamps : but no one thinks himself authorized to murmur, simply because the island is not larger than it is. Yet these are the same griefs.

The above are the two metaphysical answers which have been given to this great question. They are not the worse for being metaphysical, provided they be founded (which I think *they are*) in right reasoning : but they are of a nature too wide to be brought under our survey, and it is often difficult to apply them in the detail. Our speculations, therefore, are perhaps better employed when they confine themselves within a narrower circle.

The observations which follow are of this more limited, but more determinate, kind.

Of *bodily pain*, the principal observation, no doubt, is that which we have already made, and already dwelt upon, *viz.*, "that it is seldom the object of contrivance; that when it is so, the contrivance rests ultimately in good."

To which, however, may be added, that the annexing of pain to the means of destruction is a salutary provision; inasmuch as it teaches vigilance and caution; both gives notice of danger, and excites those endeavors which may be necessary to preservation. The evil consequence, which sometimes arises from the want of that timely intimation of danger which pain gives, is known to the inhabitants of cold countries by the example of frost-bitten limbs. I have conversed with patients, who had lost toes and fingers by this cause. They have in general told me, that they were totally unconscious of any local uneasiness at the time. Some I have heard declare, that, whilst they were about their employment, neither their situation nor the state of the air was unpleasant. They felt no pain; they suspected no mischief; till, by the application of warmth, they discovered, too late, the fatal injury which some of their extremities had suffered. I say, that this shows the use of pain, and that we stand in need of such a monitor. I believe, also, that the use extends further than we suppose, or can now trace; that to disagreeable sensations we, and all animals, owe, or have owed, many habits of action which are salutary, but which are become so familiar, as not easily to be referred to their origin.

[100] PAIN also, itself, is not without its *alleviations.* It

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[100] This chapter, we are told by Dr. Fenwick in his sketch of Dr. Clark's life, "was written when Dr. Paley was suffering under severe attacks of a painful disorder under which he had long labored, and which afterwards proved fatal." Dr. Fenwick justly remarks upon the additional interest which this circumstance communicates to the author's remarks upon the interruptions of pain.—Meadly's *Memoirs of Paley*, p. 204.

may be violent and frequent; but it is seldom both violent and long-continued: and its pauses and intermissions become positive pleasures. It has the power of shedding a satisfaction over intervals of ease, which, I believe, few enjoyments exceed. A man resting from a fit of the stone or gout, is, for the time, in possession of feelings which undisturbed health cannot impart. They may be dearly bought, but still they are to be set against the price. And, indeed, it depends upon the duration and urgency of the pain, whether they be dearly bought or not. I am far from being sure, that a man is not a gainer by suffering a moderate interruption of bodily ease, for a couple of hours out of the four-and-twenty. Two very common observations favor this opinion: one is, that remissions of pain call forth, from those who experience them, stronger expressions of satisfaction and of gratitude, towards both the Author and the instruments of their relief, than are excited by advantages of any other kind: the second is, that the spirits of sick men do not sink in proportion to the acuteness of their sufferings; but rather appear to be roused and supported, not by pain, but by the high degree of comfort which they derive from its cessation, or even its subsidency, whenever that occurs: and which they taste with a relish, that diffuses some portion of mental complacency over the whole of that mixed state of sensations in which disease has placed them.

In connexion with bodily pain may be considered bodily *disease*, whether painful or not. Few diseases are fatal. I have before me the account of a dispensary in the neighborhood, which states six years' experience as follows:—

Admitted	6,420
Cured	5,476
Dead	234

And this I suppose nearly to agree with what other similar institutions exhibit. Now, in all these cases, some disorder must have been felt, or the patients would not have applied for a remedy; yet we see how large a proportion of the maladies, which were brought forward, have either yielded to proper treatment, or, what is more probable, ceased of their own accord. We owe these frequent recoveries, and, where recovery does not take place, this patience, of the human constitution under many of the distempers by which it is visited, to two benefactions of our nature. One is, that she works within certain limits; allows of a certain latitude, within which health may be preserved, and within the confines of which it only suffers a graduated diminution. Different quantities of food, different degrees of exercise, different portions of sleep, different states of the atmosphere, are compatible with the possession of health. So likewise it is with the secretions and excretions, with many internal functions of the body, and with the state, probably, of most of its internal organs. They may vary considerably, not only without destroying life, but without occasioning any high degree of inconveniency. The other property of our nature, to which we are still more beholden, is its constant endeavor to restore itself, when disordered, to its regular course. The fluids of the body appear to possess a power of separating and expelling any noxious substance which may have mixed itself with them. This they do, in eruptive fevers, by a kind of despumation, as Sydenham calls it, analogous, in some measure, to the intestine action by which fermenting liquors work the yest to the surface. The solids, on their part, when their action is obstructed, not only resume that action, as soon as the obstruction is removed, but they struggle with the impediment. They take an action as near to the true one, as the difficulty and the disorganization with which they have to contend will allow of.

Of *mortal* diseases, the great use is to reconcile us to death. The horror of death proves the value of life. But it is in the power of disease to abate, or even extinguish, this horror; which it does in a wonderful manner, and, oftentimes, by a mild and imperceptible gradation. Every man who has been placed in a situation to observe it, is surprised with the change which has been wrought in himself, when he compares the view which he entertains of death upon a sick-bed, with the heart-sinking dismay, with which he should some time ago have met it, in health. There is no similitude between the sensations of a man led to execution, and the calm expiring of a patient at the close of his disease. Death to him is only the last of a long train of changes ; in his progress through which, it is possible that he may experience no shocks or sudden transitions.

Death itself, as a mode of removal and of succession, is so connected with the whole order of our animal world, that almost every thing in that world must be changed, to be able to do without it. It may seem likewise impossible to separate the fear of death from the enjoyment of life, or the perception of that fear from rational natures. Brutes are, in a great measure, delivered from all anxiety on this account, by the inferiority of their faculties ; or rather, they seem to be armed with the apprehension of death just sufficiently to put them upon the means of preservation, and no further. But would a human being wish to purchase this immunity at the expense of those mental powers which enable him to look forward to the future ?

Death implies *separation* : and the loss of those whom we love must necessarily, so far as we can conceive, be accompanied with pain. To the brute creation, Nature seems to have stepped in with some secret provision for their relief, under the rupture of their attachments. In their instincts towards their offspring, and of their offspring to them, I have often been surprised to observe how ardently they love, and how soon they forget. The pertinacity of human sorrow (upon which time also, at length, lays its softening hand) is probably, therefore, in some manner connected with the qualities of our rational or moral nature. One thing however is clear, *viz.*, that it is better that we should possess affections, the sources of so many virtues, and so many joys, although they be exposed to the incidents of life, as well as the interruptions of mortality, than, by the want of them, be reduced to a state of selfishness, apathy, and quietism.

Of other external evils, (still confining ourselves to what are called physical or natural evils,) a considerable part come within the scope of the following observation : —The great principle of human satisfaction is *engage-*

ment. It is a most just distinction, which the late Mr. Tucker has dwelt upon so largely in his works, between pleasures in which we are passive, and pleasures in which we are active. And, I believe, every attentive observer of human life will assent to his position, that, however grateful the sensations may occasionally be in which we are passive, it is not these, but the latter class of our pleasures, which constitute satisfaction; which supply that regular stream of moderate and miscellaneous enjoyments, in which happiness, as distinguished from voluptuousness, consists. Now for rational occupation, which is, in other words, for the very material of contented existence, there would be no place left, if either the things with which we had to do were absolutely impracticable to our endeavors, or if they were too obedient to our uses. A world, furnished with advantages on one side, and beset with difficulties, wants, and inconveniencies on the other, is the proper abode of free, rational, and active natures, being the fittest to stimulate and exercise their faculties. The very *refractoriness* of the objects they have to deal with, contributes to this purpose. A world in which nothing depended upon ourselves, however it might have suited an imaginary race of beings, would not have suited mankind. Their skill, prudence, industry; their various arts and their best attainments, from the application of which they draw, if not their highest, their most permanent gratifications, would be insignificant, if things could be either moulded by our volitions, or, of their own accord, conformed themselves to our views and wishes. Now it is in this refractoriness, that we discern the seed and principle of *physical* evil, as far as it arises from that which is external to us.

Civil evils,[101] or the evils of civil life, are much more easily disposed of, than physical evils: because they are, in truth, of much less magnitude; and also because they result, by a kind of necessity, not only from the constitution of our nature, but from a part of that constitution which no one would wish to see altered. The case is this: Mankind will, in every country, *breed up* to a certain point of distress. That point may be different in different countries or ages, according to the established usages of life in each. It will also shift upon the scale, so as to admit of a greater or less number of inhabitants, according as the quantity of provision, which is either produced in the country, or supplied to it from other countries, may happen to vary. But there must always be such a point, and the species will always breed up to it. The order of generation proceeds by something like a geometrical progression. The increase of provision, under circumstances even the most advantageous, can only assume the form of an arithmetic series. Whence it follows, that the population will always overtake the provision, will pass beyond the line of plenty, and will continue to increase till checked by the difficulty of procuring subsistence.* Such difficulty, therefore, along with its attendant circumstances, *must* be found in every old country; and these circumstances constitute what we call poverty, which necessarily imposes labor, servitude, restraint.

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[101] In all arguments respecting civil and political evils, it is important to keep the distinction steadily in view, between contentment under necessary sufferings, and quietism under such as may be avoided by improvements in our institutions. Contentment, indeed, under even the latter, is a virtue as well as a solace, during the period required for their safe and legitimate amendment; but this is no exception to the rule which we have glanced at; for the sufferings must be considered necessary until their removal can be safely effected.—Eng. Ed.

It seems impossible to people a country with inhabitants who shall be all easy in circumstances. For suppose the thing to be done, there would be such marrying and giving in marriage amongst them, as would in a few years change the face of affairs entirely: *i. e.*, as would increase the consumption of those articles which supplied the natural or habitual wants of the country, to such a degree of scarcity, as must leave the greatest part of the inhabitants unable to procure them without toilsome endeavors; or, out of the different kinds of these articles, to procure any kind except that which was most easily produced. And this, in fact, describes the condition of the mass of the community in all countries: a condition unavoidably, as it should seem, resulting from the provision which is made in the human, in common with all animal constitutions, for the perpetuity and multiplication of the species.

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* See a statement of this subject in a late treatise upon population.—*Note of the Author.*

It need not, however, dishearten any endeavors for the public service, to know that population naturally treads upon the heels of improvement. If the condition of a people be meliorated, the consequence will be, either that the *mean* happiness will be increased, or a greater number partake of it; or, which is most likely to happen, that both effects will take place together. There may be limits fixed by Nature to both; but they are limits not yet attained, nor even approached, in any country of the world.

And when we speak of limits at all, we have respect only to provisions for animal wants. There are sources, and means, and auxiliaries, and augmentations of human happiness, communicable without restriction of numbers; as capable of being possessed by a thousand persons as by one. Such are those which flow from a mild, contrasted with a tyrannic government, whether civil or domestic; those which spring from religion; those which grow out of a sense of security; those which depend upon habits of virtue, sobriety, moderation, order; those, lastly, which are found in the possession of well-directed tastes and desires, compared with the dominion of tormenting, pernicious, contradictory, unsatisfied, and unsatisfiable passions.

The *distinctions* of civil life, are apt enough to be regarded as evils by those who sit under them; but, in my opinion, with very little reason.

In the first place, the advantages which the higher conditions of life are supposed to confer, bear no proportion in value to the advantages which are bestowed by Nature. The gifts of Nature always surpass the gifts of fortune. How much, for example, is activity better than attendance; beauty than dress; appetite, digestion, and tranquil bowels, than all the studies of cookery, or than the most costly compilation of forced or far-fetched dainties!

Nature has a strong tendency to equalization. Habit, *the instrument* of Nature, is a great leveller; the familiarity which it induces, taking off the edge both of our pleasures and our sufferings. Indulgences which are habitual, keep us in ease, and cannot be carried much further. So that, with respect to the gratifications of which the senses are capable, the difference is by no means proportionable to the apparatus. Nay, so far as superfluity generates fastidiousness, the difference is on the wrong side.

It is not necessary to contend, that the advantages derived from wealth are none, (under due regulations they are certainly considerable,) but that they are not greater than they ought to be. *Money* is the sweetener of human toil; the substitute for coercion; the reconciler of labor with liberty. It is, moreover, the stimulant of enterprise in all projects and undertakings, as well as of diligence in the most beneficial arts and employments. Now, did affluence, when possessed, contribute nothing to happiness, or nothing beyond the mere supply of necessaries,—and the secret should come to be discovered,—we might be in danger of losing great part of the uses, which are at present derived to us, through this important medium. Not only would the tranquillity of social life be put in peril, by the want of a motive to attach men to their private concerns ; but the satisfaction which all men receive from success in their respective occupations, which collectively constitutes the great mass of human comfort, would be done away in its very principle.

With respect to *station*, as it is distinguished from riches, whether it confer authority over others, or be invested with honors which apply solely to sentiment and imagination, the truth is that what is gained by rising through the ranks of life, is not more than sufficient to draw forth the exertions of those who are engaged in the pursuits which lead to advancement, and which, in general, are such as ought to be encouraged. Distinctions of this sort, are subjects much more of competition than of enjoyment, and in that competition their use consists. It is not, as hath been rightly observed, by what the *Lord Mayor* feels in his coach, but by what the *apprentice* feels who gazes at him, that the public is served.

As we approach the summits of human greatness, the comparison of good and evil, with respect to personal comfort, becomes still more problematical; even allowing to ambition all its pleasures. The poet asks, "What is grandeur, what is power?" The philosopher answers, "Constraint and plague: *et in maximâ quâque fortunâ minimum licere.*"* One very common error misleads the opinion of mankind on this head, *viz.*, that, universally, authority is pleasant, submission painful. In the general course of human affairs, the very reverse of this is nearer the truth. Command is anxiety, obedience ease.

Artificial distinctions sometimes promote real equality. Whether they be hereditary, or be the homage paid to office, or the respect attached by public opinion to particular professions, they serve to *confront* that grand and unavoidable distinction which arises from property, and which is most overbearing where there is no other. It is of the nature of property, not only to be irregularly distributed, but to run into large masses. Public laws should be so constructed, as to favor its diffusion as much as they can. But all that can be done by laws, consistently with that degree of government of his property which ought to be left to the subject, will not be sufficient to counteract this tendency. There must always, therefore, be the difference between rich and poor; and this difference will be the more grinding, when no pretension is allowed to be set up against it.

So that the evils, if evils they must be called, which spring either from the necessary subordinations of civil life, or from the distinctions which have naturally, though not necessarily, grown up in most societies, so long as they are unaccompanied by privileges injurious or oppressive to the rest of the community, are such as may, even by the most depressed ranks, be endured with very little prejudice to their comfort.

The mischiefs of which mankind are the occasion to one another, by their private wickedness and cruelties; by tyrannical exercises of power; by rebellions against just authority; by wars; by national jealousies and competitions, operating to the destruction of third countries; or by other instances of misconduct, either in individuals or societies, are all to be resolved into the character of man as a *free agent*. Free agency, in its very essence, contains liability to abuse. Yet, if you deprive man of his free agency, you subvert his nature. You may have order from him and regularity, as you may from the tides or the trade-winds, but you put an end to his moral character, to virtue, to merit, to accountableness, to the use indeed of reason. To which must be added the observation, that even the bad qualities of mankind have an origin in their good ones. The case is this: Human passions are either necessary to human welfare, or capable of being made, and, in a great majority of instances, in fact made, conducive to its happiness. These passions are strong and general; and, perhaps, would not answer their purpose unless they were so. But strength and generality, when it is expedient that particular circumstances should be respected, become, if left to themselves, excess and misdirection. From which excess and misdirection, the vices of mankind (the causes, no doubt, of much misery) appear to spring. This account, whilst it shows us the principle of vice, shows us, at the same time, the province of reason and of self-government; the want, also, of every support which can be procured to either from the aids of religion; and it shows this, without having recourse to any native, gratuitous malignity in the human constitution. Mr. Hume, in his posthumous dialogues, asserts, indeed, of *idleness*, or aversion to labor, (which he states to lie at the root of a considerable part of the evils which mankind suffer,) that it is simply and merely bad. But how does he distinguish idleness from the love of ease? or is he sure, that the love of ease in individuals is not the chief foundation of social tranquillity? It will be found, I believe, to be true, that in every community there is a large class of its members, whose idleness is the best quality about them, being the corrective of other bad ones. If it were possible, in every instance, to give a right determination to industry, we could never have too much of it. But this is not possible, if men are to be free. And without this, nothing would be so dangerous, as an incessant, universal, indefatigable activity. In the civil world, as well as in the material, it is the *vis inertiæ* which keeps things in their places.

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* [And the least possible enjoyment in any the fairest fortune.—Am. Ed.]

[ON THE ORIGIN OF EVIL.

The question which has, more than any other, harassed metaphysical reasoners, but especially theologians, and upon which it is probable that no very satisfactory conclusion will ever be reached by the human faculties in our present state, is the Origin and Sufferance of Evil. * * * * * * Is the question wholly incapable of solution, which these learned and ingenious men have so entirely failed in solving? Must the difficulty remain for ever unsurmounted, and only be approached to discover that it is insuperable? Must the subject, of all others the most interesting for us to know well, be to us always as a sealed book, of which we can never know any thing? From the nature of the thing—from the question relating to the operation of a power which, to our limited faculties, must ever be incomprehensible, there seems too much reason for believing, that nothing precise or satisfactory ever will be attained by human reason, regarding this great argument; and that the bounds which limit our view will only be passed, when we have quitted the encumbrances of our mortal state, and are permitted to survey those regions beyond the sphere of our present circumscribed existence. The other branch of Natural Theology, that which investigates the evidences of Intelligence and Design, and leads us to a clear apprehension of the Deity's power and wisdom, is as satisfactorily cultivated as any other department of science, rests upon the same species of proof, and affords results as precise as they are sublime. This branch will never be distinctly known, and will always so disappoint the inquirer, as to render the lights of Revelation peculiarly acceptable, although even those lights leave much of it still involved in darkness—still mysterious and obscure.

Yet let us endeavor to suggest some possible explication, while we admit that nothing certain, nothing entirely satisfactory can be reached. The failure of great writers may well teach us humility, make us distrust ourselves, and moderate within us any sanguine hopes of success. But they should not make us wholly despair of at least showing, in what direction the solution of the difficulty is to be sought, and whereabouts it will probably be found situated, when our feeble reason shall be strengthened and expanded. For one cause of their discomfiture certainly has been, their aiming too high; attempting a complete solution of a problem, which only admitted of approximation, and discussion of limits.*

It is admitted on all hands, that the demonstration is complete, which shows the existence of intelligence and design in the universe. The structure of the eye and ear, in exact conformity to the laws of optics and acoustics, shows as clearly as any experiment can show any thing, that the source, cause, or origin is common both to the properties of light, and the formation of the lenses and retina in the eye—both to the properties of sound and the tympanum, malleus, incus, and stapes of the ear. No doubt whatever can exist upon this subject, any more than, if we saw a particular order issued to a body of men, to perform certain uncommon evolutions, and afterwards saw the same body performing those same evolutions, we could doubt their having received the order. A designing and intelligent and skilful Author of these admirably adapted works, is equally a clear inference from the same facts. We can no more doubt it, than we can question, when we see a mill grinding corn into flour, that the machinery was made by some one, who designed by means of it to prepare the materials of bread. The same conclusions are drawn, in a vast variety of other instances, both with respect to the parts of human and other bodies, and with respect to most of the other arrangements of Nature. Similar conclusions are also drawn from our consciousness, and the knowledge which it gives us of the structure of the mind. Thus we find, that attention quickens memory, and enables us to recollect; and that habit renders all exertions and all acquisitions easy, besides having the effect of alleviating pain.

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* An inquiry or discussion of limits, or a limitary investigation, in mathematics, is where we seek to know within what limits a solution must be found, as it were, whereabouts.

But when we carry our survey into other parts, whether of the natural or moral system, we cannot discover any design at all. We frequently perceive structures, the use of which we know nothing about; parts of the animal frame that apparently have no functions to perform—nay, that are the source of pain, without yielding any perceptible advantage; arrangements and movements of bodies, which are of one particular kind; and yet we are quite at a loss to discern any reason, why they might not have been of many other descriptions; operations of Nature that seem to serve no purpose whatever; and other operations, and other arrangements, chosen equally without any beneficial view, and yet which often give rise to much apparent confusion and mischief. Now, the question is, *first*, whether, in any one of these cases of arrangement and structures with no visible object at all, we can for a moment suppose, that there really is no object answered, or only conceive that we have been unable to discover it? *Secondly*, whether, in the cases where mischief sometimes is perceived, and no other purpose appears to be effected, we do not almost as uniformly lay the blame on our own ignorance, and conclude, not that the arrangement was made without any design, and that mischief arises without any contriver, but that if we knew the whole case, we should find a design and contrivance, and also that the apparent mischief would sink into the general good? It is not necessary to admit, for our present purpose, this latter proposition, though it brings us closer to the matter in hand; it is sufficient for the present to admit, what no one doubts, that when a part of the body, for instance, is discovered, to which, like the spleen, we cannot assign any function in the animal system, we never think of concluding that it is made for no use, but only that we have as yet not been able to discover its use.

Now let us ask, why do we arrive, and without any hesitation whatever, or any exception whatever, always and immediately arrive, at this conclusion respecting intelligence and design? Nothing could be more unphilosophical, nay, more groundless, than such a process of reasoning, if we had only been able to trace design in one or two instances; for instance, if we found only the eye to show proofs of contrivance, it would be wholly gratuitous, when we saw the ear, to assume that it was adapted to the nature of sound, and still more so, if, on examination, we perceived it bore no perceptible relation to the laws of acoustics. The proof of contrivance in one particular, is nothing like a proof, nay, does not even furnish the least presumption of contrivance, in other particulars; because, *à priori*, it is just as easy to suppose one part of Nature to be designed for a purpose, and another part, nay, all other parts, to be formed at random and without any contrivance, as to suppose that the formation of the whole is governed by design. Why, then, do we, invariably and undoubtingly, adopt the course of reasoning which has been mentioned, and never for a moment suspect any thing to be formed without some reason—some rational purpose? The only ground of this belief is, that we have been able distinctly to trace design in so vast a majority of cases, as leaves us no power of doubting that, if our faculties had been sufficiently powerful, or our investigation sufficiently diligent, we should also have been able to trace it, in those comparatively few instances, respecting which we still are in the dark.

It may be worth while to give a few instances of the ignorance, in which we once were, of design in some important arrangements of Nature, and of the knowledge which we now possess, to show the purpose of their formation. Before Sir Isaac Newton's optical discoveries, we could not tell why the structure of the eye was so complex, and why several lenses and humors were required, to form a picture of objects upon the retina. Indeed, until Dolland's subsequent discovery of the achromatic effect of combining various glasses, and Mr. Blair's still more recent experiments on the powers of different refracting media, we were not able distinctly to perceive the operation and use of the complicacy in the structure of the eye. We now well understand its nature, and are able to comprehend, how that, which had at one time, nay for ages, seemed to be an unnecessary complexity, forms the most perfect of all optical instruments, and according to the most certain laws of refraction and of dispersion.

So, too, we had observed for some centuries, the forms of the orbits in which the heavenly bodies move, and we had found these to be ellipses with a very small eccentricity. But why this was the form of those orbits, no one could even conjecture. If any person, the most deeply skilled in mathematical science, and the most internally convinced of the universal prevalence of design and contrivance in the structure of the universe, had been asked, what reason there was for the planets moving in ellipses so nearly approaching to circles, he could not have given any good reason, at least beyond a guess. The force of gravitation, even admitting that to be, as it were, a condition of the creation of matter, would have made those bodies revolve in ellipses of any degree of eccentricity just as well, provided the angle and the force of projection had been varied. Then why was this form, rather than any other, chosen? No one knew; yet no one doubted that there was ample reason for it. Accordingly, the sublime discoveries of Lagrange and Laplace, have shown us, that this small eccentricity is one material element in the formula, by which it is shown, that all the irregularities of the system are periodical, and that the deviation never can exceed a certain amount on either hand.

But, again, while we were ignorant of this, perhaps the most sublime truth in all science, we were always arguing as if the system had an imperfection, as if the disturbing forces of the different planets and the sun, acting on one another, constantly changed the orbits of each planet, and must, in a course of ages, work the destruction of the whole planetary arrangement, which we had contemplated with so great admiration, and with awe. It was deemed enough, if we could show that this derangement must be extremely slow; and that, therefore, the system might last for many more ages, without requiring *an interposition* of omnipotent skill to preserve it, by rectifying its motions. Thus one of the most celebrated writers above-cited, Dr. T. Burnet, argues that, " from the nature of gravitation and the concentricity of the orbits, the irregularities produced are so slowly operated in contracting, dilating, and inclining those orbits, that the system may go on for many thousand years before any extraordinary interference becomes necessary in order to correct it." And Dr. Burnet adds, that "those small irregularities cast no discredit on the good contrivance of the whole." Nothing, however, could cast greater discredit, if it were as he supposed, and as all men previous to the late discoveries supposed ; it was only, they rather think, a " small irregularity," which was every hour tending to the destruction of the whole system, and which must have deranged or confounded its whole structure long before it destroyed it. Yet now we see, that the wisdom, to which a thousand years are as one day, not satisfied with constructing a fabric which might last for " many thousand years without His interference," has so formed it that it may thus endure for ever.*

Now, if such be the grounds of our belief in the universal prevalence of Design, and such the different lights, which at different periods of our progress in science we possess, upon this great branch of the Divine government; if we undoubtingly believe that contrivance is universal, only because we can trace and comprehend it in a great majority of instances, and if the number of exceptions to the rule is occasionally diminished, as our knowledge of the particulars is, from time to time, extended—may we not apply the same principle to the apprehension of Benevolent purpose, and infer, from the number of instances in which we plainly perceive a good intention, that if we were better acquainted with those cases in which a contrary intention is now apparent, we should there too find the generally pervading character of Benevolence to prevail? Not only is this the manner in which we reason, respecting the design of the Creator, from examining His works ; it is the manner in which we treat the conduct of our fellow-creatures. A man of the most extensive nevolence and strictest integrity in his general deport has done something equivocal; nay, something apparen harsh and cruel; we are slow to condemn him; we giv him credit for acting with a good motive, and for a righteous purpose; we rest satisfied, that "if we only knew every thing, he would come out blameless." This arises from a just and a sound view of human character, and its general consistency with itself. The same reasoning may surely be applied, with all humility and reverence, to the works and the intentions of the great Being, who has implanted in our mind the principles, which lead to that just and sound view of the deeds and motives of men.

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* If the retardation of Encke's comet, or other facts, should lead to the belief of general derangement from an Ether, who will now be bold enough to doubt, that further discovery may show the adjustment of this also ?

But let the argument be rested upon our course of reasoning respecting Divine contrivance. The existence of evil is in no case more apparent, than the existence of disorder seems to be in many things. To go no further than the last example which has been given—the mathematician could perceive the derangement in the planetary orbits, could demonstrate that it must ensue from the mutual action of the heavenly bodies on each other, could calculate its progress with the utmost exactness, could tell, with all nicety, how much it would alter the forms of the orbits in a given time, could foresee the time when the whole system must be irretrievably destroyed by its operation, as a mathematical certainty. Nothing that we call evil, can be much more certainly perceived than this derangement, of itself an evil, certainly a great imperfection, if the system was observed by the mind of man as we regard human works. Yet we now find, from well considering some things which had escaped attention, that the system is absolutely free from derangement; that all the disturbances counterbalance each other; and that the orbits never can either be flattened or bulged out, beyond a definite and a very inconsiderable quantity. Can any one doubt, that there is also a reason for even this small and limited, this regular and temporary, derangement? Why it exists at all, or in any the least degree, we as yet know not. But who will presume to doubt, that it has a reason, which would at once satisfy our minds were known to us? Nay, who will affirm that the discovery may not yet be in reserve, for some later and happier age? Then are we not entitled to apply the same reasoning to what at present appears Evil, in a system of which, after all we know of it, so much still remains concealed from our view?

The mere act of creation in a Being of wisdom so admirable, and power so vast, seems to make it extremely probable, that perfect goodness accompanies the exertion of his perfect skill. There is something so repugnant to all our feelings, but also to all the conceptions of our reason, in the supposition of such a Being desiring the misery, for its own sake, of the beings whom He voluntarily called into existence and endowed with a sentient nature, that the mind naturally and irresistibly recoils from such a thought. But this is not all. If the nature of that great Being were evil, His power being unbounded, there would be some proportion between the amount of ills, and the monuments of that power. Yet we are struck dumb with the immensity of His works to which no imperfection can be ascribed, and in which no evil can be traced; while the amount of mischief that we see, might sink into a most insignificant space, and is such as a being of most inconsiderable power, and very limited skill, could easily have accomplished. This is not the same consideration with the balance of good against evil; and inquirers do not seem to have sufficiently attended to it. The argument, however, deserves much attention, for it is purely and strictly inductive. The Divine nature is shown to be clothed with prodigious power, and incomparable wisdom and skill,—power and skill so vast, and so exceeding our comprehension, that we ordinarily term them infinite, and are only inclined to conceive the possibility of limiting, by the course of the argument upon evil, one alternative of which is assumed to raise an exception.* But admitting, on account of the question under discussion, that we have only a right to say the power and skill are prodigiously great, though possibly not boundless, they are plainly shown in the phenomena of the universe to be the attributes of a Being, who, if evil-disposed, could have made the monuments of Ill upon a scale resembling those of Power and Skill; so that, if those things which seem to us Evil, be really the result of a mischievous design in such a Being, we cannot comprehend why they are upon so entirely different a scale. This is a strong presumption from the facts, that we are wrong, in imputing those appearances to such a disposition. If so, what seems evil must needs be capable of some other explanation, consistent with Divine goodness,—that is to say, would not prove to be evil at all, if we knew the whole of those facts.

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* The dilemma of the Epicureans, "Aut vult et non potest tollere mala." [He desires, and is not able, to remove evil.—AM. ED.]

But it is necessary to proceed a step further, especially with a view to the fundamental position now contended for, the extending to the question of Benevolence the same principles which we apply to that of Intelligence. The Evil which exists, or that which we suppose to be Evil, not only is of a kind and a magnitude requiring inconceivably less power and less skill than the admitted good of the creation—it also bears a very small proportion in amount; quite as small a proportion as the cases of unknown or undiscoverable design bear to those of acknowledged and proved contrivance. Generally speaking, the preservation and the happiness of sensitive creatures, appears to be the great object of creative exertion and conservative providence. The expanding of our faculties, both bodily and mental, is accompanied with pleasure; the exercise of those powers is almost always attended with gratification; all labor so acts as to make rest peculiarly delicious; much of labor is enjoyment; the gratification of those appetites, by which both the individual is preserved and the race is continued, is highly pleasurable to all animals; and it must be observed, that instead of being attracted by grateful sensations to do anything requisite for our good, or even our existence, we might have been just as certainly urged by the feeling of pain, or the dread of it, which is a kind of suffering in itself. Nature, then, resembles the lawgiver who, to make his subjects obey, should prefer holding out rewards for compliance with his commands, rather than denounce punishments for disobedience. But Nature is yet more kind; she is gratuitously kind; she not only prefers inducement to threat or compulsion, but she adds more gratification than was necessary to make us obey her calls. How well might all creation have existed, and been continued, though the air had not been balmy in spring, or the shade and the spring refreshing in summer; had the earth not been enamelled with flowers, and the air scented with perfumes! How needless for the propagation of plants was it, that the seed should be enveloped in fruits the most savory to our palate; and if those fruits serve some other purpose, how foreign to that purpose was the formation of our nerves, so framed as to be soothed or excited by their flavor! We here perceive Design, because we trace adaptation. But we at the same time perceive Benevolent Design, because we perceive gratuitous and supererogatory enjoyment bestowed. Thus, too, see the care with which animals of all kinds are tended from their birth. The mother's instinct is not more certainly the means of securing and providing for her young, than her gratification in the act of maternal care is great, and is also needless for making her perform that duty. The grove is not made vocal during pairing and incubation, in order to secure the laying or the hatching of eggs; for, if it were as still as the grave, or were filled with the most discordant croaking, the process would be as well performed. So, too, mark the care with which injuries are remedied by what has been correctly called the *vis medicatrix.** Is a muscle injured?—Suppuration takes place, the process of granulation succeeds, and new flesh is formed to supply the gap; or if that is less wide, a more simple healing process knits together the severed parts. Is a bone injured?—A process commences, by which an extraordinary secretion of bony matter takes place, and the void is supplied. Nay, the irreparable injury of a joint gives rise to the formation of a new hinge, by which the same functions may be not inconveniently, though less perfectly, performed. Thus, too, recovery of vigor after sickness is provided for by increased appetite; but there is here superadded, generally, a feeling of comfort and lightness, an enjoyment of existence so delightful, that it is a common remark, how nearly this compensates the sufferings of the illness. In the economy of the mind it is the same thing. All our exertions are stimulated by curiosity, and the gratification is extreme of satisfying it. But it might have been otherwise ordered, and some painful feeling might have been made the only stimulant to the acquisition of knowledge. So the charm of novelty is proverbial; but it might have been the unceasing cause of the most painful alarms. Habit renders every thing easy; but the repetition might have only increased the annoyance. The loss of one organ makes the others more acute. But the partial injury might have caused, as it were, a general paralysis. It is thus that Paley is well justified in exclaiming, "It is a happy world after all!" The pains and the sufferings, bodily and mental, to which we are exposed, if they do not sink into nothing, at least retreat within comparatively narrow bounds; the ills are hardly seen, when we survey the great and splendid picture of worldly enjoyment or ease.

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* [The healing power.—AM. ED.]

But the existence of considerable misery is undeniable; and the question is, of course, confined to that. Its exaggeration, in the ordinary estimate both of the vulgar and of skeptical reasoners, is equally certain. Paley, Bishop Sumner, as well as Derham, King, Ray, and others of the older writers, have made many judicious and generally correct observations upon its amount, and they, as well as some of the able and learned authors of the Bridgewater Treatises, have done much in establishing deductions necessary to be made, in order that we may arrive at the true amount. That many things, apparently unmixed evils, when examined more narrowly prove to be partially beneficial, is the fair result of their well-meant labors; and this, although any thing rather than a proof that there is no Evil at all, yet is valuable as still further proving the analogy between this branch of the argument and that upon *Design; and* in giving hopes, that all may possibly be found hereafter to be good, as every thing will assuredly be found to be contrived with an intelligent and useful purpose. It may be right to add a remark or two upon some evils, and those of the greatest magnitude in the common estimate of human happiness, with a view of further illustrating this part of the subject.

Mere imperfection must altogether be deducted from the account. It never can be contended, that any evil nature can be ascribed to the First Cause, merely for not having endowed sentient creatures with greater power or wisdom, for not having increased and multiplied the sources of enjoyment, or for not having made those pleasures which we have more exquisitely grateful. No one can be so foolish as to argue, that the Deity is either limited in power, or deficient in goodness, because He has chosen to create some beings of a less perfect order than others. The mere negation in the creating of some, indeed of many, nay, of any conceivable number of desirable attributes, is therefore no proper evidence of evil design or of limited power in the Creator; it is no proof of the existence of Evil properly so called. But does not this also erase death from the catalogue of ills? It might well please the Deity to create a mortal being—a being which, consisting of soul and body, was only to live upon this earth for a limited number of years. If when that time has expired, this being is removed to another and a superior state of existence, no evil whatever accrues to it from the change; and all views of the government of this world lead to the important and consolatory conclusion, that such is the design of the Creator; that He cannot have bestowed on us minds capable of such expansion and culture, only to be extinguished when they have reached their highest pitch of improvement; or if this be considered as begging the question, by assuming benevolent design, we cannot easily conceive, that while the mind's force is so little affected by the body's decay, the destruction or dissolution of the latter should be the extinction of the former. But that death operates as an evil of the very highest kind in two ways is obvious; the dread of it often imbitters life, and the death of friends brings to the mind by far its most painful infliction; certainly the greatest suffering it can undergo without any criminal consciousness of its own.

For this evil, then—this grievous and admitted evil—how shall we account? But first, let us consider whether it be not unavoidable; not merely under the present dispensation, and in the existing state of things, for that is wholly irrelevant to the question which is raised upon the fitness of this very state of things; but whether it be not a necessary evil. That man might have been created immortal is not denied; but if it were the will of the Deity to form a limited being, and to place him upon the earth for only a certain period of time, his death was the necessary consequence of this determination. Then as to the pain which one person's removal inflicts upon surviving parties, this seems the equally necessary consequence of their having affections. For, if any being feels love towards another, this implies his desire that the intercourse with that other should continue; or, which is the same thing, the repugnance and aversion to its ceasing; that is, he must suffer affliction for that removal of the beloved object. To create sentient beings devoid of all feelings of affection, was no doubt possible to Omnipotence; but to endow those beings with such feelings, as should give the constant gratification derived from the benevolent affections, and yet to make them wholly indifferent to the loss of the objects of those affections, was not possible even for Omnipotence; because it was a contradiction in terms, equivalent to making a thing both exist and not exist, at one and the same time. Would there have been any considerable happiness in a life stripped of these kindly affections? We cannot affirm that there would not, because we are ignorant what other enjoyments might have been substituted for the indulgence of them. But neither can we affirm, that any such substitution could have been found; and it lies upon those who deny the necessary connexion between the human mind, or any sentient being's mind, and grief for the loss of friends, to show that there are other enjoyments, which could furnish an equivalent to the gratification derived from the benevolent feelings. The question then reduces itself to this: Wherefore did a Being, who could have made sentient beings immortal, choose to make them mortal? or, Wherefore has He placed man upon the earth for a time only? or, Wherefore has He set bounds to the powers and capacities which He has been pleased to bestow upon his creature? and this is a question which we certainly never shall be able to solve; but a question extremely different from the one more usually put,—How happens it that a good Being has made a world full of misery and death?

In the necessary ignorance wherein we are of the whole designs of the Deity, we cannot wonder if some things, nay, if many things, are to our faculties inscrutable. But we assuredly have no right to say, that those difficulties which try and vex us, are incapable of a solution, any more than we have to say, that those cases, in which as yet we can see no trace of design, are not equally the result of intelligence, and equally conducive to a fixed and useful purpose, with those in which we have been able to perceive the whole, or nearly the whole, scheme. Great as have been our achievements in physical astronomy, we are as yet wholly unable to understand, why a power pervades the system acting inversely as the squares of the distance from the point to which it attracts, rather than a power acting according to any other law; and why it has been the pleasure of the almighty Architect of that universe, that the orbits of the planets should be nearly circular, instead of approaching to, or being exactly the same, with many other trajectories of a nearly similar form, though of other properties; nay, instead of being curves of a wholly different class and shape. Yet we never doubt, that there was a reason for this choice; nay, we fancy it possible that even on earth we may hereafter understand it, more clearly than we now do; and never question that, in another state of being, we may be permitted to enjoy the contemplation of it. Why should we doubt that, at least in that higher state, we may also be enabled to perceive such an arrangement, as shall make evil wholly disappear from our present system, by showing us that it was necessary and inevitable, even in the works of the Deity; or, which is the same thing, that its existence conduces to such a degree of perfection and of happiness upon the whole, as could not, even by Omnipotence, be attained without it; or, which is also the same thing, that the whole creation as it exists, taking both worlds together, is perfect, and incapable of being in any particular changed, without being made worse and less perfect?

Taking both worlds together—For certainly, were our views limited to the present sublunary state, we may well affirm, that no solution whatever could even be imagined of the difficulty—If we are never again to live; if those we here loved are for ever lost to us; if our faculties can receive no further expansion; if our mental powers are only trained and improved to be extinguished at their acme—then, indeed, are we reduced to the melancholy and gloomy dilemma of the Epicureans; and Evil is confessed to checker, nay almost to cloud over, our whole lot, without the possibility of comprehending why, or of reconciling its existence with the supposition of a Providence at once powerful and good. But this inference is also an additional argument for a future state, when we couple it with those other conclusions respecting the economy of the world, to which we are led by wholly different routes, when we investigate the phenomena around us and within us.

Suppose, for example, it should be found, that there are certain purposes which can in no way whatever—no conceivable way—be answered, except by placing man in a state of trial or probation; suppose the essential nature of mind shall be found to be such, that it could not, in any way whatever, exist so as to be capable of the greatest purity and improvement—in other words, the highest perfection—without having undergone a probation; or suppose it should be found impossible, to communicate certain enjoyments to rational and sentient beings, without having previously subjected them to certain trials and certain sufferings—as, for instance, the pleasures derived from a consciousness of perfect security, the certainty that we can suffer and perish no more—this surely is a possible supposition. Now, to continue the last example—Whatever pleasure there is in the contrast between ease and previous vexation or pain, whatever enjoyment we derive from the feeling of absolute security, after the vexation and uncertainty of a precarious state, implies a previous suffering—a previous state of precarious enjoyment; and not only implies it but necessarily implies it, so that the power of Omnipotence, itself, could not convey to us the enjoyment, without having given us the previous suffering. Then is it not possible, that the object of an all-powerful and perfectly-benevolent Being, should be to create like beings, to whom as entire happiness, as complete and perfect enjoyment, should be given as any created beings—that is, any being, except the Creator Himself—can by possibility enjoy? This is certainly not only a very possible supposition, but it appears to be quite consistent with, if it be not a necessary consequence of, His being perfectly good as well as powerful and wise. Now we have shown, therefore, that such being supposed the design of Providence, even Omnipotence itself could not accomplish this design, as far as one great and important class of enjoyments is concerned, without the previous existence of some pain, some misery. Whatever gratification arises from relief—from contrast—from security succeeding anxiety—from restoration of lost affections—from renewing severed connexions—and many others of a like kind, could not by any possibility be enjoyed, unless the correlative suffering had first been undergone. Nor will the argument be at all impeached by observing, that one Being may be made to feel the pleasure of ease and security by seeing others subjected to suffering and distress; for that assumes the infliction of misery on those others; it is "*alterius* spectare laborem"* that we are supposing to be sweet; and this is still partial evil.

As the whole argument respecting evil must, from the nature of the question, resolve itself into either a proof of some absolute or mathematical necessity not to be removed by infinite power, or the showing that some such proof may be possible although we have not yet discovered it,* an illustration may naturally be expected to be attainable from mathematical considerations. Thus we have already adverted to the law of periodical† irregularities in the solar system. Any one, before it was discovered, seemed entitled to expatiate upon the operation of the disturbing forces arising from mutual attraction, and to charge the system arranged upon the principle of universal gravitation with want of skill, nay, with leading to inevitable mischief,—mischief or evil of so prodigious an extent, as to exceed incalculably all the instances of evil and of suffering which we see around us in this single planet. Nevertheless, what then appeared so clearly to be a defect and an evil, is now well known to be the very absolute perfection of the whole heavenly architecture.

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* [The contemplation of the suffering of another.—AM. ED.]

Again, we may derive a similar illustration from a much more limited instance, but one immediately connected with strict mathematical reasoning, and founded altogether in the nature of necessary truth. The problem has been solved by mathematicians, Sir Isaac Newton having first investigated it, of finding the form of a symmetrical solid, or solid of revolution, which in moving through a fluid shall experience the least possible resistance; in other words, of finding the form that must be impressed upon any given bulk of matter, so that it shall move more easily through a surrounding fluid than if it had any other conceivable form whatever, with a breadth or a length also given. The figure bears a striking resemblance to that of a fish. Now suppose a fish were formed exactly in this shape, and that some animal endowed with reason, were placed upon a portion of its surface, and able to trace its form for only a limited extent, say at the narrow part, where the broad portion or end of the moving body was opposed, or seemed as if it were opposed, to the surrounding fluid when the fish moved,—the reasoner would at once conclude, that the contrivance of the fish's form was very inconvenient and inartificial, and that nothing could be much worse adapted for expeditious or easy movement through the waters. Yet it is certain, that upon being afterwards permitted to view THE WHOLE body of the fish, what had seemed a defect and an evil, not only would appear plainly to be none at all, but it would appear manifest, that this seeming evil or defect, was a part of the most perfect and excellent structure, which it was possible even for Omnipotence and Omniscience to have adopted, and that no other conceivable arrangement could, by possibility, have produced so much advantage, or tended so much to fulfil the design in view. Previous to being enlightened by such an enlarged view of the whole facts, it would thus be a rash and unphilosophical thing in the reasoner, whose existence we are supposing, to pronounce an unfavorable opinion. Still more unwise would it be, if numerous other observations had evinced traces of skill and goodness in the fish's structure. The true and the safe conclusion would be, to suspend an opinion, which could only be unsatisfactorily formed upon imperfect data ; and to rest in the humble hope and belief that one day all would appear for the best.*

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* This proposition has been overlooked by many reasoners, as we have seen above; yet is manifestly true.

† These derangements are also called *secular* to distinguish them from others which are termed periodical. But in the view of our argument both are of a periodical kind.

OF CONFLICTING INSTINCTS AND CONFLICTING CONTRIVANCES GENERALLY.

This subject is deserving of attention, because the facts are curious, and the appearances are attended with much difficulty to the theological inquirer. But it belongs properly to the general head of evil, or apparent evil and imperfection. Nor is there any reason to expect that we shall ever, in the present limited state of our faculties, and while placed in a narrow and bounded state of existence, be able to penetrate the obscurity which surrounds the question upon every side.

When the expression, *conflicting instincts*, is employed, it does not so much denote instincts conflicting in the same nature, for example, in the same animal or tribe of animals, as that the instinct with which one is endowed, appears to be given it for the purpose of counteracting, thwarting, frustrating, or evading some other instinct bestowed upon another animal. Thus the contrivances, by which one tribe endeavors to seize another and make prey of it, are in conflict with those by which the latter endeavor to defend themselves or to escape. The sepia, or cuttle-fish, voids a black liquid, which prevents another fish from finding it, or continuing its pursuit. The woodpecker is led to strike its long bill violently into branches, where certain insects lie instinctively concealing themselves to escape destruction. Certain birds build their nests so as to avoid the reptiles which swarm around, and have the natural appetite to feed upon those birds. This, however, may be referred to reasoning on the one hand, and mere appetite on the other. But animals that prey upon others, are led by undoubted instinct to seek the places where they are to be found, and to breed at the seasons when they are, in consequence of other instincts, produced, so as to become the food of the former. Some animals seem made, or at least provided, with appetites on purpose to devour the embryos of others, or prevent their increase. Thus, some fish feed on the spawn of others, and the ichneumon feeds upon the eggs of the crocodile.

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* See further illustrations of these remarks under the head of *Researches on Fossil Osteology*—APPENDIX.

Akin to such conflicting instincts, or rather forming the physical, as these compose the mental, class, are contrivances of a kind apparently designed one to counteract the other. This is particularly observable in the structure of animals, as taken in connexion with their habits. Thus, some beasts of prey are formed for running down, some for springing upon other animals, which, on their part, are provided with forms that favor their escape. The lion and tiger have vertebræ connected with their ribs and with each other, so as to facilitate by a lateral mobility their crawling and leaping. On the other hand, the spines of deer and hares, and other defenceless animals, have the vertebræ so contrived as to facilitate their escape, and the eyes so placed as to warn them of attacks from *behind,* and from the sides, as well as in front. The serpent's backbone is a singular and a beautiful structure. It has three or four times the usual number of joints, and they play on one another like ball and socket. The poison, too, of the few venomous species is curiously secreted in a bag placed beneath a movable tooth, which is perforated with a tube or duct that terminates in the poison sac, and is continued to the sharp point on the other end, so that when the animal bites, the tooth, pressing on the sac, makes the poison squirt through the duct of the tooth into the wound made by its point. No more striking proof of design can be given than this. Then the rattle in the tail of the most deadly of the tribe, gives warning to keep out of its way, and thus, as it were, prevent the machinery of destruction from being of any use to the animal, unless, perhaps, as a weapon of defence, when he is attacked by some one that disregards the warning. Again, birds are furnished with a defence or shield to protect their eyes in flying through the thickets. They are also furnished with a power of contracting their eyes, so as to adjust them to the distances of various objects. But birds of prey have a peculiar mechanism for this purpose. Their eye is provided with a kind of muscle, loop-like, which enables them to compress the lens so as to adjust it for descrying objects at a vast distance, acting like the slide of a telescope, and used to effect the same purpose, that is, to suit the focus of the eye. Now this can be of no use excepting as a means of attack and destruction; for the adjustment to near distances can alone help the animal to defend itself. On the other hand, weak birds are furnished with many important means of escaping from their more powerful enemies. Similar observations may be made upon the structure and habits of fishes. Thus the sword-fish is provided with a most powerful weapon, and with great muscular strength to use it. He attacks the whale, which immediately, and by a special instinct, dives into so deep water, that the sword-fish, being wholly unable to bear the pressure, is forced to quit his hold. This pressure produces no inconvenience to the whale, whose structure is formed to bear it with perfect ease.

The *vis medicatrix*, in all its branches, affords striking examples of the same conflict. For while the animal body is exposed to injury from its formation, the qualities of its component parts, and the properties of other bodies, and while it is also exposed to injury from disease, there is bestowed upon it a power of not only resisting and avoiding those injuries, but also of repairing them after they have been inflicted. Thus the eye is so fixed in the socket, and so protected by the eyelashes and the eyebrow, that irritating particles do not easily reach its tender surface, or perhaps we should rather say, the tender and sensitive parts surrounding it. But if any thing does fix upon it, there is provided a sudden and copious secretion of watery fluid, which sheathes the parts attacked, and tends to wash away or expel the foreign substance that has intruded itself. So new bone and new flesh are produced, to supply any void made by accidents, and to make the severed parts knit again and heal. In like manner, when an extraneous substance has, by the laws of matter and motion, been introduced into any limb, or into the cavities of the body, and cannot be removed, a new formation of flesh, or cartilage, or bone, according to the place where it is imbedded, takes place, and covers it over, so as to defend the adjacent parts and enable the system to be continued in its operations. Again, where a disease attacks the frame, according to the properties of the system on the one hand, and the qualities of infection or other noxious effluvia on the other hand, the system is thrown into a state which produces a sudden and often violent effort to throw off the mischief; or if this fails, then other efforts are made to resist and to remedy the damage sustained, and to restore health.

All these conflicts and inconsistencies belong to the general head of imperfection, or of evil. They are merely other cases of what we have specified, with various views in the argument upon that great question. They fall altogether within the scope of that argument; therefore they require no separate discussion in this place. It is quite evident, that we have no more right to regard a *conflict of contrivances* as any real inconsistency, in reference to the whole design which is concealed from us, than we have to regard any part as formed without meaning and use, because we have not discovered its use. We cannot say, that one part of a machine counteracts another part, unless we can perceive distinctly what the purpose of the whole mechanism is. The apparent opposition may be necessary for accomplishing that purpose : as the friction of one wheel upon another is necessary to the action of both, or the counteraction of one lever by another to the motion of the whole.

VIS MEDICATRIX.*

This interesting subject has already been considered as connected with Evils of Imperfection. It furnishes, however, so many striking proofs of design, that some further remarks may be added.

Some have objected to the expression, as grounded upon an assumption,—the hypothesis, that Nature acts, in each instance, for the purpose of remedying some mischief which has been done. But the facts are undeniable : a healing process takes place ; a remedial effect is produced ; and the expression only states the fact. It may be added, that the power is sometimes preventive or prophylactic also. Thus the tendency of some poisons taken into the stomach, is to induce vomiting, which throws out the offensive matter before it can produce its deleterious effects. Such, perhaps, is also the tendency of profuse perspirations, to throw off a malady in the first instance, and prevent it from taking hold of the system. When these preventives fail, the remedial power is required and comes into action.

So convinced have some anatomists been, by daily observation, of a kind of active power pervading and moving the system, that some speak of the vital energies as if thought as well as life could be predicated of the parts of our system. The celebrated John Hunter is an example. That great and original physiologist, being free from any tendency to refining, and as little certainly as any one under the dominion of vulgar prejudices, speaks familiarly of limbs and bones acting in disease, or when suffering from injuries, as if they had an intention of inflaming, and knew how to execute it. This habit of expressing himself, could only have resulted from constantly observing the exact adaptation of natural operations to the uses and wants of the system in each occasion, and the exact coincidence, in point of time as well as in proportion, of the supply with the demand.

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* [The healing power.—AM. ED.]

The formation of bony matter when a fracture has taken place, and the pieces of the broken bone are required to be knit together again, has been mentioned before, and the whole process is striking and instructive. First, blood is poured out into the fracture; it coagulates; soon after, very small or capillary blood-vessels shoot into the coagulated blood; the blood disappears; gelatinous matter alone remains; this gradually hardens; and bony particles are deposited, which fill up the break and knit the bone. Where a dislocation has taken place, there is no similar process; but as soon as the luxation is reduced, and the bones are replaced, in a very little while all the fine apparatus of the joint is restored with wonderful perfection, so as speedily to obliterate the traces of the mischief. Even where the restorative process has proved inadequate, and a distortion takes place, as when, by some natural defect in the firmness of some bones, they sink under the pressure of the body, a new weight being thrown upon other bones, these are strengthened additionally for the purpose of enabling them to meet the new demand upon their powers. Thus the leg and thigh bones are fortified by additional secretions of bony matter, and these are thrown up on the yielding side, and perpendicularly to the line of pressure, with as manifest a design of strengthening, as is shown by those who shore or prop an old wall. Again, when, after a fracture the bone of the limb is set, the ends may overlap, and thus the limb be shortened. What then shall become of the muscles which had been of a length to fit the former size of the bone? Those muscles immediately begin to shorten much beyond their original natural contraction, and they acquire a power of further contraction to suit the altered length of the bone. It is, as if upon any accident happening to one part of a steam-engine, whereby it had changed its dimensions, the neighboring parts, wholly unaffected by the accident, were of themselves to change their dimensions or their position, so that their action should also be varied, and varied exactly to suit the alteration in the part affected; thus continuing the movement of the machine, but in a different adjustment, and all without any interference of the engineer.

The throwing out of new vessels, or enlarging smaller lateral ones, in order to continue the circulation, where a large or main one has been stopped up, or cut through, is another example of a kind equally striking. But the whole progress of aneurism affords perhaps the most remarkable instance of any when that progress is fully gone through. This, as is well known, is a tumor formed by the partial bursting or giving way of an artery; and if the vessel be of any considerable size, death must immediately ensue, but for a process which as immediately takes place. The blood which escapes on the rupture of the vessel, coagulates and becomes solid. A kind of temporary plug is thus afforded, and time gained for a more durable repair being supplied, by a more solid work being executed. Coagulable lymph is formed and thrown out, and it soon becomes firm membrane. Layer after layer of this is deposited, so that a bandage or coating is provided sufficiently strong to resist the continual pressure from the impulse of the blood. Thus the inflammatory action which ensued upon the rupture, produces a new substance required for counteracting the effects of that rupture, and enabling the artery to continue performing its functions, as a conduit for carrying the blood to its destination; and this fluid itself supplies the materials, with which the breach in the conduit used for carrying and distributing it, is first temporarily plugged and then repaired, as if the water in a pipe were to secrete, first a sediment or lute to make the channel water-tight, and then different plates of metal and braces, to mend the pipes wherever its own pressure had burst them.

A similar provision is observable where a tumor has been formed in any muscular part of the body. It results from a morbid action of those parts ; but in the progress of the disease a barrier is thrown up, likewise formed out of the blood ; a hard welt, of a firm condensed membrane, is formed surrounding the tumor, and interposed between it and the healthy portion of the limb.

In the case of aneurism, however, there is a still more remarkable provision added. The pressure must be relieved of the main stream of blood upon the channel, which is no longer of sufficient strength to resist it. Accordingly, blood-vessels, which before had hardly been discernible, begin to work with new energy, and are enlarged in their capacity. These run parallel to the artery injured, and convey the blood, so that the requisite supply continues to be afforded, but by a new system, formed and in operation for the relief of the injured channel as soon as its damage has, by the first natural operation, been repaired. What engineer—what Smeaton, or even Watt himself, ever constructed a pipe, such that, when it was fractured, it could not only provide itself with a plug, to stay immediate mischief and enable the machine to go on, but could also provide splices for a permanent repair ; and not only that, but could of itself, immediately after the accident, form new conduits, and other parts, exactly fitted to continue the general movement, but also to afford such relief as the injured part required,—relief exactly proportioned at once to the amount of the weakness occasioned, and to the extent of the service required ? And all this without the necessity of the engineer himself being once appealed to, or any extraneous aid called in. Is there any thing like this in all the works of these great men ? Is there any thing more marvellous even in the works of the grand Artist Himself ? Yes—for He too made the minds as well as the bodies of those men ; and the wondrous mechanism of such minds as theirs, and those of the Newtons and Laplaces, which proceeded from the same hand, incomparably surpasses all the marvels of their bodily structure. —LORD BROUGHAM.]

NATURAL THEOLOGY has ever been pressed with this question,—Why, under the regency of a supreme and benevolent Will, should there be in the world so much as there is of the appearance of *chance*?

The question in its whole compass lies beyond our reach: but there are not wanting, as in the origin of evil, answers, which seem to have considerable weight in particular cases, and also to embrace a considerable number of cases.

I. There must be *chance* in the midst of design: by which we mean, that events which are not designed, necessarily arise from the pursuit of events which are designed. One man travelling to York, meets another man travelling to London. Their meeting is by chance, is accidental, and so would be called and reckoned, though the journeys which produced the meeting were, both of them, undertaken with design and from deliberation. The meeting, though accidental, was nevertheless hypothetically necessary, (which is the only sort of necessity that is intelligible:) for if the two journeys were commenced at the time, pursued in the direction, and with the speed, in which and with which, they were in fact begun and performed, the meeting could not be avoided. There was not, therefore, the less necessity in it for its being by chance. Again, the rencounter might be most unfortunate, though the errand, upon which each party set out upon his journey, were the most innocent or the most laudable. The by-effect may be unfavorable, without impeachment of the proper purpose, for the sake of which the train, from the operation of which these consequences ensued, was put in motion. Although no cause act without a good purpose, accidental consequences, like these, may be either good or bad.

II. The *appearance of chance* will always bear a proportion to the ignorance of the observer. The cast of a die as regularly follows the laws of motion, as the going of a watch; yet, because we can trace the operation of those laws through the works and movements of the watch, and cannot trace them in the shaking or throwing of the die, (though the laws be the same, and prevail equally in both cases,) we call the turning up of the number of t die, chance, the pointing of the index of the watch, m chinery, order, or by some name which excludes chance. It is the same in those events which depend upon the will of a free and rational agent. The verdict of a jury, the sentence of a judge, the resolution of an assembly, the issue of a contested election, will have more or less the appearance of chance, might be more or less the subject of a wager, according as we were less or more acquainted with the reasons which influenced the deliberation. The difference resides in the information of the observer, and not in the thing itself; which, in all the cases proposed, proceeds from intelligence, from mind, from counsel, from design.

Now when this one cause of the appearance of chance, *viz.*, the ignorance of the observer, comes to be applied to the operations of the Deity, it is easy to foresee how fruitful it must prove of difficulties and of seeming confusion. It is only to think of the Deity, to perceive what variety of objects, what distance of time, what extent of space and action, his counsels may, or rather must, comprehend. Can it be wondered at, that, of the purposes which dwell in such a mind as this, so small a part should be known to us? It is only necessary, therefore, to bear in our thought, that in proportion to the inadequateness of our information, will be the quantity in the world of apparent chance.

III. In a great variety of cases, and of cases comprehending numerous subdivisions, it appears, for many reasons, to be better that events rise up by *chance*, or, more properly speaking, with the appearance of chance, than according to any observable rule whatever. This is not seldom the case even in human arrangements. Each person's place and precedency, in a public meeting, may be determined by *lot*. Work and labor may be *allotted*. Tasks and burdens may be *allotted*:

> ———Operumque laborem
> Partibus æquabat justis, aut *sorte* trahebat.*

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* [He divided the labor of the works in just proportion, or assigned it by lot.—AM. ED.]

ilitary service and station may be *allotted*. The disbution of provision may be made by *lot*, as it is in a sailor's mess; in some cases also, the distribution of favors may be made by *lot*. In all these cases, it seems to be acknowledged, that there are advantages in committing events to chance, superior to those which would or could arise from regulation. In all these cases also, though events rise up in the way of chance, it is by appointment that they do so.

In other events, and such as are independent of human will, the reasons for this preference of uncertainty to rule appear to be still stronger. For example: it seems to be expedient that the period of human life should be *uncertain*. Did mortality follow any fixed rule, it would produce a security in those that were at a distance from it, which would lead to the greatest disorders; and a horror in those who approached it, similar to that which a condemned prisoner feels on the night before his execution. But, that death be uncertain, the young must sometimes die, as well as the old. Also, were deaths never *sudden*, they who are in health would be too confident of life. The strong and the active, who want most to be warned and checked, would live without apprehension or restraint. On the other hand, were sudden deaths very frequent, the sense of constant jeopardy would interfere too much with the degree of ease and enjoyment intended for us; and human life be too precarious for the business and interests which belong to it. There could not be dependence either upon our own lives, or the lives of those with whom we were connected, sufficient to carry on the regular offices of human society. The manner, therefore, in which death is made to occur, conduces to the purposes of admonition, without overthrowing the necessary stability of human affairs.[102]

[102] It must never be forgotten that, according to the scheme, whether of Natural or of Revealed Religion, the doctrine of a Future State removes one branch of the evil here treated of, and answers the common skeptical objection grounded upon the destruction of one being made the means of benefit to another. In the view of religion, the person removed by Providence is to be considered as suffering no loss whatever,—he is at once taken to a superior state. The survivors alone are to be considered as regards the question of evil.—ENG. ED.

Disease being the forerunner of death, there is the same reason for its attacks coming upon us under the appearance of chance, as there is for uncertainty in the time of death itself.

The *seasons* are a mixture of regularity and chance. They are regular enough to authorize expectation, whilst their being, in a considerable degree, irregular, induces, on the part of the cultivators of the soil, a necessity for personal attendance, for activity, vigilance, precaution. It is this necessity which creates farmers; which divides the profit of the soil between the owner and the occupier; which, by requiring expedients, by increasing employment, and by rewarding expenditure, promotes agricultural arts and agricultural life, of all modes of life the best, being the most conducive to health, to virtue, to enjoyment. I believe it to be found, in fact, that where the soil is the most fruitful, and the seasons the most constant, there the condition of the cultivators of the earth is the most depressed. Uncertainty, therefore, has its use even to those who sometimes complain of it the most. Seasons of scarcity themselves are not without their advantages. They call forth new exertions; they set contrivance and ingenuity at work: they give birth to improvements in agriculture and economy; they promote the investigation and management of public resources.

Again: there are strong intelligible reasons, why there should exist in human society great disparity of *wealth* and *station;* not only as these things are acquired in different degrees, but at the first setting out of life. In order, for instance, to answer the various demands of civil life, there ought to be amongst the members of every civil society a diversity of education, which can only belong to an original diversity of circumstances. As this sort of disparity, which ought to take place from the beginning of life, must, *ex hypothesi*, be previous to the merit or demerit of the persons upon whom it falls, can it be better disposed of than by chance? *Parentage* is that sort of chance: yet it is the commanding circumstance which in general fixes each man's place in civil life, along with every thing which appertains to its distinctions. It may be the result of a beneficial rule, that the fortunes or honors of the father devolve upon the son; and, as it should seem, of a still more necessary rule, that the low or laborious condition of the parent be communicated to his family; but with respect to the successor himself, it is the drawing of a ticket in a lottery. Inequalities, therefore, of fortune, at least the greatest part of them, *viz.*, those which attend us from our birth, and depend upon our birth, may be left, as they are left, to *chance*, without any just cause for questioning the regency of a supreme Disposer of events.

But not only the donation, when by the necessity of the case they must be gifts, but even the *acquirability* of civil advantages, ought perhaps, in a considerable degree, to lie at the mercy of chance. Some would have all the virtuous rich, or, at least, removed from the evils of poverty, without perceiving, I suppose, the consequence, that all the poor must be wicked. And how such a society could be kept in subjection to government, has not been shown: for the poor, that is, they who seek their subsistence by constant manual labor, must still form the mass of the community; otherwise the necessary labor of life could not be carried on; the work could not be done, which the wants of mankind in a state of civilization, and still more in a state of refinement, require to be done.

It appears to be also true, that the exigencies of social life, call not only for an original diversity of *external* circumstances, but for a mixture of different faculties, tastes, and tempers. Activity and contemplation, restlessness and quiet, courage and timidity, ambition and contentedness, not to say even indolence and dulness, are all wanted in the world, all conduce to the well going on of human affairs, just as the rudder, the sails, and the ballast of a ship, all perform their part in the navigation. Now, since these characters require for their foundation different original talents, different dispositions, perhaps also different bodily constitutions; and since, likewise, it is apparently expedient, that they be promiscuously scattered amongst the different classes of society,—can the distribution of talents, dispositions, and the constitutions upon which they depend, be better made than by *chance* ?

The *opposites* of apparent chance, are constancy and sensible interposition ; every degree of *secret* direction being consistent with it. Now of *constancy*, or of fixed and known rules, we have seen in some cases the inapplicability ; and inconveniencies which we do not see, might attend their application in other cases.

Of *sensible* interposition, we may be permitted to remark, that a Providence, always and certainly distinguishable, would be neither more nor less than miracles rendered frequent and common. It is difficult to judge of the state into which this would throw us. It is enough to say, that it would cast us upon a quite different dispensation from that under which we live. It would be a total and radical change. And the change would deeply affect, or perhaps subvert, the whole conduct of human affairs. I can readily believe, that, other circumstances being adapted to it, such a state might be better than our present state. It may be the state of other beings ; it may be ours hereafter. But the question with which we are now concerned is, how far it would be consistent with our condition, supposing it in other respects to remain as it is ? And in this question, there seem to be reasons of great moment on the negative side. For instance : so long as bodily labor continues, on so many accounts, to be necessary for the bulk of mankind, any dependency upon supernatural aid, by unfixing those motives which promote exertion, or by relaxing those habits which engender patient industry, might introduce negligence, inactivity, and disorder, into the most useful occupations of human life ; and thereby deteriorate the condition of human life itself.

As moral agents, we should experience a still greater alteration ; of which more will be said under the next article.

Although, therefore, the Deity, who possesses the power of winding and turning, as He pleases, the course of causes which issue from Himself, do, in fact, interpose to alter or intercept effects which, without such interposition, would have taken place ; yet it is by no means incredible that His Providence, which always rests upon final good, may have made a *reserve* with respect to the manifestation of His interference, a part of the very plan which He has appointed for our terrestrial existence, and a part conformable with, or in some sort required by, other parts of the same plan. It is, at any rate, evident, that a large and ample province remains for the exercise of Providence, without its being naturally perceptible by us ; because obscurity, when applied to the interruption of laws, bears a necessary proportion to the imperfection of our knowledge when applied to the laws themselves, or rather to the effects which these laws, under their various and incalculable combinations, would of their own accord produce. And if it be said, that the doctrine of Divine Providence, by reason of the ambiguity under which its exertions present themselves, can be attended with no *practical* influence upon our conduct ; that, although we believe ever so firmly that there is a Providence, we must prepare, and provide, and act, as if there were none ; I answer, that this is admitted ; and that we further allege, that so to prepare, and so to provide, is consistent with the most perfect assurance of the reality of a Providence : and not only so, but that it is, probably, one advantage of the present state of our information, that our provisions and preparations are not disturbed by it. Or if it be still asked, Of what use at all, then, is the doctrine, if it neither alter our measures nor regulate our conduct ? I answer again, that it is of the greatest use, but that it is a doctrine of sentiment and piety, not (immediately at least) of action or conduct ; that it applies to the consolation of men's minds, to their devotions, to the excitement of gratitude, the support of patience, the keeping alive and the strengthening of every motive for endeavoring to please our Maker ; and that these are great uses.[103]

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[103] **The views taken in these three paragraphs, are most important, and they lead to another of equal moment, (if, indeed, they do not include it,) respecting the obscurity which hangs over the subject of a Future State. Skeptics have constantly asked,—Why a matter, beyond**

OF ALL VIEWS under which human life has ever been considered, the most reasonable, in my judgement, is that which regards it as a state of *probation*. If the course of the world was separated from the contrivances of Nature, I do not know that it would be necessary to look for any other account of it than what, if it may be called an account, is contained in the answer, that events rise up by chance. But since the contrivances of Nature decid-

all comparison the most important and the most interesting to man, should be left in any the least doubt? in other words, Why the combined operation of Natural and Revealed Religion, should not be to make us just as certain of what shall befall us upon our removal from this world, as we are of what is likely to happen on the morrow of any given day? The answer is,—*because* this matter is so immeasurably more important and more interesting to us than all others; and *because*, unless our whole nature were changed, the absolute certainty of enjoyments without end and without limit, would make the performance of our present task impossible. If, indeed, the further question is pressed,—"Why are we so constituted?"—this is only another form of what in truth, all these reasonings conceal, the question, Why man was created a finite being? For in this, all the skeptical questions, of the description adverted to, invariably end. Thus, to take an instance from one gratification, which of necessity presupposes evil,—There is pleasure in the cessation of pain, and in the enjoyment of rest after labor; as there also is, in satisfying the thirst for knowledge. It is not a contingent, but a necessary truth, that this gratification of ease, or of curiosity satisfied, cannot be obtained without the preceding evil of suffering or fatigue, or the preceding imperfection of ignorance. But it is said, why might we not have been so made as to have other equal pleasures without the evil? And had such been our constitution, the same objectors would have said,—"Here is one source of enjoyment cut off." Nay, if life were an alternation of positive enjoyment with mere ease, they would still say,—"Why any interval of positive enjoyment, compared with which, mere ease is worthless, and so an evil?" And if all were positive enjoyment, they would say,—"Why is it not more exquisite?" In other words,—"Why is man a finite being?" All our speculations, however, upon this subject, must proceed upon the assumption, that the design of Providence was to create a finite, mortal creature, endowed with free will, but influenced by motives inducing and dissuading. Any inquiry into the reason for such a determination being taken by the Supreme Being, far exceeds the bounds of our faculties; and the question as to evil, must be always handled with the impression that, beyond a certain way, we never can make progress towards its entire solution. The whole subject, with the different doctrines held upon it, will be treated at large in the Appendix, where it will be contended that the most enlarged views lead to the conclusion of rational optimism and a probationary state.—*ENG. ED.*

edly evince *intention*; and since the course of the world and the contrivances of Nature have the same Author; we are, by the force of this connexion, led to believe that the appearance under which events take place, is reconcilable with the supposition of design on the part of the Deity. It is enough that they be reconcilable with this supposition; and it is undoubtedly true, that they may be reconcilable, though we cannot reconcile them. The mind, however, which contemplates the works of Nature, and in those works, sees so much of means directed to ends, of beneficial effects brought about by wise expedients, of concerted trains of causes terminating in the happiest results; so much, in a word, of counsel, intention, and benevolence; a mind, I say, drawn into the habit of thought which these observations excite, can hardly turn its view to the condition of our own species, without endeavoring to suggest to itself some purpose, some design, for which the state in which we are placed is fitted, and which it is made to serve. Now we assert the most probable supposition to be, that it is a state of moral probation; and that many things in it suit with this hypothesis which suit no other. It is not a state of unmixed happiness, or of happiness simply; it is not a state of designed misery, or of misery simply: it is not a state of retribution; it is not a state of punishment. It suits with none of these suppositions. It accords much better with the idea of its being a condition calculated for the production, exercise, and improvement of moral qualities, with a view to a future state in which these qualities, after being so produced, exercised, and improved, may, by a new and more favorable constitution of things, receive their reward, or become their own. If it be said, that this is to enter upon a religious, rather than a philosophical consideration, I answer, that the name of Religion ought to form no objection, if it shall turn out to be the case that the more religious our views are, the more probability they contain. The degree of beneficence, of benevolent intention, and of power, exercised in the construction of sensitive beings, goes strongly in favor, not only of a creative, but of a continuing care, that is, of a ruling Providence. The degree of chance which appears to prevail in the world, requires to be reconciled with this hypothesis. Now it is one thing to maintain the doctrine of Providence along with that of a future state, and another thing without it. In my opinion, the two doctrines must stand or fall together. For, although more of this apparent chance may, perhaps, upon other principles, be accounted for, than is generally supposed, yet a future state alone rectifies all disorders : and if it can be shown, that the appearance of disorder is consistent with the uses of life as a *preparatory* state, or that in some respects it promotes these uses, then, so far as this hypothesis may be accepted, the ground of the difficulty is done away.

In the wide scale of human condition, there is not perhaps one of its manifold diversities, which does not bear upon the design here suggested. Virtue is infinitely various. There is no situation in which a rational being is placed, from that of the best-instructed Christian down to the condition of the rudest barbarian, which affords not room for moral agency ; for the acquisition, exercise, and display of voluntary qualities, good and bad. Health and sickness, enjoyment and suffering, riches and poverty, knowledge and ignorance, power and subjection, liberty and bondage, civilization and barbarity, have all their offices and duties, all serve for the *formation* of character : for when we speak of a state of trial, it must be remembered that characters are not only tried, or proved, or detected, but that they are generated also, and *formed*, by circumstances. The best dispositions may subsist under the most depressed, the most afflicted fortunes. A West-Indian slave, who amidst his wrongs, retains his benevolence, I, for my part, look upon as amongst the foremost of human candidates for the rewards of virtue. The kind master of such a slave, that is, he, who, in the exercise of an inordinate authority, postpones, in any degree, his own interest to his slave's comfort, is likewise a meritorious character ; but still he is inferior to his slave. All, however, which I contend for is, that these destinies, opposite as they may be in every other view, are both *trials* ; and equally such. The observation may be applied to every other condition; to the whole range of the scale, not excepting even its lowest extremity. *Savages* appear to us all alike; but it is owing to the distance at which we view savage life, that we perceive in it no discrimination of character. I make no doubt but that moral qualities, both good and bad, are called into action as much, and that they subsist in as great variety, in these inartificial societies, as they are or do, in polished life. Certain at least it is, that the good and ill treatment which each individual meets with, depends more upon the choice and voluntary conduct of those about him, than it does or ought to do, under regular civil institutions and the coercion of public laws. So again, to turn our eyes to the other end of the scale, namely, that part of it which is occupied by mankind enjoying the benefits of learning, together with the lights of revelation; there, also, the advantage is all along *probationary*. Christianity itself, I mean the revelation of Christianity, is not only a blessing but a trial. It is one of the diversified means by which the character is exercised: and they who require of Christianity, that the revelation of it should be universal, may possibly be found to require that one species of probation should be adopted, if not to the exclusion of others, at least to the narrowing of that variety, which the wisdom of the Deity hath appointed to this part of his moral economy.*

Now if this supposition be well founded; that is, if it be true that our ultimate, or our most permanent happiness, will depend, not upon the temporary condition into which we are cast, but upon our behavior in it; then is it a much more fit subject of *chance* than we usually allow or apprehend it to be, in what manner the variety of external circumstances, which subsist in the human world, is distributed amongst the individuals of the species. "This life being a state of probation, it is immaterial," says

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* The reader will observe, that I speak of the revelation of Christianity, as distinct from Christianity itself. The *dispensation* may already be universal. That part of mankind which never heard of CHRIST's name, may nevertheless be redeemed, that is, be placed in a better condition, with respect to their future state, by his intervention; may be the objects of his benignity and intercession, as well as of the propitiatory virtue of his passion. But this is not "natural theology;" therefore I will not dwell longer upon it.—*Note of the Author.*

Rousseau, "what kind of trials we experience in it, provided they produce their effects." Of two agents who stand indifferent to the moral Governor of the universe, one may be exercised by riches, the other by poverty. The treatment of these two shall appear to be very opposite, whilst in truth it is the same; for though, in many respects, there be great disparity between the conditions assigned, in one main article there may be none, *viz.*, in that they are alike trials; have both their duties and temptations, not less arduous or less dangerous in one case than the other; so that if the final award follow the character, the original distribution of the circumstances under which that character is formed, may be defended upon principles not only of justice but of equality. What hinders, therefore, but that mankind may draw lots for their condition? They take their portion of faculties and opportunities, as any unknown cause, or concourse of causes, or as causes acting for other purposes, may happen to set them out: but the event is governed by that which depends upon themselves, the application of what they have received. In dividing the talents, no rule was observed; none was necessary: in rewarding the use of them, that of the most correct justice. The chief difference at last appears to be, that the right use of more talents, *i. e.*, of a greater trust, will be more highly rewarded than the right use of fewer talents, *i. e.*, of a less trust. And since, for other purposes, it is expedient that there be an inequality of concredited talents here, as well probably as an inequality of conditions hereafter, though all remuneratory,—can any rule, adapted to that inequality, be more agreeable, even to our apprehensions of distributive justice, than this is?

We have said, that the appearance of *casualty* which attends the occurrences and events of life, not only does not interfere with its uses, as a state of probation, but that it promotes these uses.

Passive virtues, of all others the severest and the most sublime; of all others, perhaps, the most acceptable to the Deity,—would, it is evident, be excluded from a constitution in which happiness and misery regularly followed virtue and vice. Patience and composure under distress, affliction, and pain; a steadfast keeping up of our confidence in God, and of our reliance upon his final goodness, at the time when every thing present is adverse and discouraging; and (what is no less difficult to retain) a cordial desire for the happiness of others, even when we are deprived of our own; these dispositions, which constitute, perhaps, the perfection of our moral nature, would not have found their proper office and object in a state of avowed retribution; and in which, consequently, endurance of evil would be only submission to punishment.

Again: one man's sufferings may be another man's trial. The family of a sick parent is a school of filial piety. The charities of domestic life, and not only these, but all the social virtues, are called out by distress. But then misery, to be the proper object of mitigation, or of that benevolence which endeavors to relieve, must be really or apparently casual. It is upon such sufferings alone that benevolence can operate. For, were there no evils in the world but what were punishments, properly and intelligibly such, benevolence would only stand in the way of justice. Such evils, consistently with the administration of moral government, could not be prevented or alleviated, that is to say, could not be remitted in whole or in part, except by the authority which inflicted them, or by an appellate or superior authority. This consideration, which is founded in our most acknowledged apprehensions of the nature of penal justice, may possess its weight in the Divine counsels. Virtue perhaps is the greatest of all ends. In human beings, relative virtues form a large part of the whole. Now relative virtue presupposes, not only the existence of evil, without which it could have no object, no material to work upon, but that evils be apparently, at least, *misfortunes*; that is, the effects of apparent chance. It may be in pursuance, therefore, and in furtherance of the same scheme of probation, that the evils of life are made so to present themselves.

I have already observed, that when we let in religious considerations, we often let in light, upon the difficulties of Nature. So in the fact now to be accounted for, the *degree* of happiness which we usually enjoy in this life, may be better suited to a state of trial and probation, than a greater degree would be. The truth is; we are rather too much delighted with the world, than too little. Imperfect, broken, and precarious as our pleasures are, they are more than sufficient to attach us to the eager pursuit of them. A regard to a *future* state, can hardly keep its place as it is. If we were designed, therefore, to be influenced by that regard, might not a more indulgent system, a higher or more uninterrupted state of gratification, have interfered with the design? At least it seems expedient, that mankind should be susceptible of this influence, when presented to them; that the condition of the world should not be such, as to exclude its operation, or even to weaken it more than it does. In a religious view, (however we may complain of them in every other,) privation, disappointment, and satiety are not without the most salutary tendencies.

CHAPTER XXVII.

CONCLUSION.

In all cases, wherein the mind feels itself in danger of being confounded by variety, it is sure to rest upon a few strong points, or perhaps upon a single instance. Amongst a multitude of proofs, it is *one* that does the business. If we observe in any argument, that hardly two minds fix upon the same instance, the diversity of choice shows the strength of the argument, because it shows the number and competition of the examples. There is no subject, in which the tendency to dwell upon select or single topics is so usual, because there is no subject, of which, in its full extent, the latitude is so great, as that of natural history applied to the proof of an intelligent Creator. For my part, I take my stand in human anatomy; and the examples of mechanism I should be apt to draw out, from the copious catalogue which it supplies, are the pivot upon which the head turns, the ligaments within the socket of the hip-joint, the pulley or trochlear muscles of the eye, the epiglottis, the bandages which tie down the tendons of the wrist and instep, the slit or perforated muscles at the hands and feet, the knitting of the intestines to the mesentery, the course of the chyle into the blood, and the constitution of the sexes, as extended throughout the whole of the animal creation. To these instances, the reader's memory will go back, as they are severally set forth in their places: there is not one of the number which I do not think decisive; not one which is not strictly mechanical: nor have I read or heard of any solution of these appearances, which, in the smallest degree, shakes the conclusion that we build upon them.

But, of the greatest part of those, who, either in this book or any other, read arguments to prove the existence of a God, it will be said, that they leave off only where they began; that they were never ignorant of this great truth, never doubted of it; that it does not therefore appear, what is gained by researches, from which no new opinion is learned, and upon the subject of which no proofs were wanted. Now I answer that, by *investigation*, the following points are always gained, in favor of doctrines even the most generally acknowledged, (supposing them to be true,) *viz.*, stability and impression. Occasions will arise to try the firmness of our most habitual opinions. And upon these occasions, it is a matter of incalculable use to feel our foundation; to find a support in argument, for what we had taken up upon authority. In the present case, the arguments upon which the conclusion rests, are exactly such as a truth of universal concern ought to rest upon. "They are sufficiently open to the views and capacities of the unlearned, at the same time that they acquire new strength and lustre from the discoveries of the learned." If they had been altogether abstruse and recondite, they would not have found their way to the understandings of the mass of mankind; if they had been *merely popular*, they might have wanted solidity.

But, secondly, what is gained by research in the stability of our conclusion, is also gained from it in *impression*. Physicians tell us, that there is a great deal of difference between taking a medicine, and the medicine getting into the constitution. A difference not unlike which obtains, with respect to those great moral propositions, which ought to form the directing principles of human conduct. It is one thing to assent to a proposition of this sort ; another, and a very different thing, to have properly imbibed its influence. I take the case to be this : perhaps almost every man living has a particular train of thought, into which his mind glides and falls, when at leisure from the impressions and ideas that occasionally excite it : perhaps, also, the train of thought, here spoken of, more than any other thing, determines the character. It is of the utmost consequence, therefore, that this property of our constitution be well regulated. Now it is by frequent or continued meditation upon a subject, by placing a subject in different points of view, by induction of particulars, by variety of examples, by applying principles to the solution of phenomena, by dwelling upon proofs and consequences, that mental exercise is drawn into any particular channel. It is by these means, at least, that we have any power over it. The train of spontaneous thought, and the choice of that train, may be directed to different ends, and may appear to be more or less judiciously fixed, according to the purpose in respect of which we consider it : but, in a *moral view*, I shall not, I believe, be contradicted when I say, that, if one train of thinking be more desirable than another, it is that which regards the phenomena of Nature with a constant reference to a supreme intelligent Author. To have made this the ruling, the habitual sentiment of our minds, is to have laid the foundation of every thing which is religious. The world thenceforth becomes a temple, and life itself one continued act of adoration. The change is no less than this ; that, whereas formerly God was seldom in our thoughts, we can now scarcely look upon any thing without perceiving its relation to Him. Every organized natural body, in the provisions which it contains for its sustentation and propagation, testifies a care, on the part of the Creator, expressly directed to these purposes. We are on all sides surrounded by such bodies; examined in their parts, wonderfully curious; compared with one another, no less wonderfully diversified. So that the mind, as well as the eye, may either expatiate in variety and multitude, or fix itself down to the investigation of particular divisions of the science. And in either case it will rise up from its occupation, possessed by the subject, in a very different manner, and with a very different degree of influence, from what a mere assent to any verbal proposition which can be formed, concerning the existence of the Deity,—at least that merely complying assent with which those about us are satisfied, and with which we are too apt to satisfy ourselves,—will or can produce upon the thoughts. More especially may this difference be perceived, in the degree of admiration and of awe, with which the Divinity is regarded, when represented to the understanding by its own remarks, its own reflections, and its own reasonings, compared with what is excited by any language that can be used by others. The works of Nature want only to be contemplated. When contemplated, they have every thing in them which can astonish by their greatness; for, of the vast scale of operation through which our discoveries carry us, at one end we see an intelligent Power arranging planetary systems, fixing, for instance, the trajectory of *Saturn*, or constructing a ring of two hundred thousand miles diameter, to surround his body, and be suspended like a magnificent arch over the heads of his inhabitants; and, at the other, bending a hooked tooth, concerting and providing an appropriate mechanism, for the clasping and reclasping of the filaments of the feather of the humming-bird. We have proof, not only of both these works proceeding from an intelligent Agent, but of their proceeding from the same Agent: for, in the first place, we can trace an identity of plan, a connexion of system, from Saturn to our own globe; and when arrived upon our globe, we can, in the second place, pursue the connexion through all the organized, especially the animated bodies which it supports. We can observe marks of a common relation, as well to one another, as to the elements of which their habitation is composed. Therefore one mind hath planned, or at least hath prescribed a general plan for, all these productions. One Being has been concerned in all.

Under this stupendous Being we live. Our happiness, our existence, is in His hands. All we expect must come from Him. Nor ought we to feel our situation insecure. In every nature, and in every portion of nature, which we can descry, we find attention bestowed upon even the minutest parts. The hinges in the wings of an *earwig*, and the joints of its antennæ, are as highly wrought, as if the Creator had had nothing else to finish. We see no signs of diminution of care by multiplicity of objects, or of distraction of thought by variety. We have no reason to fear, therefore, our being forgotten, or overlooked, or neglected.[104]

The existence and character of the Deity is, in every view, the most interesting of all human speculations. In none, however, is it more so, than as it facilitates the belief of the fundamental articles of *Revelation*. It is a step to have it proved, that there must be something in the world more than what we see. It is a further step to know, that, amongst the invisible things of Nature, there must be an intelligent Mind, concerned in its production, order, and support. These points being assured to us by Natural Theology, we may well leave to Revelation the disclosure of many particulars, which our researches cannot reach, respecting either the nature of this Being, as the original cause of all things, or His character and designs as a moral Governor; and not only so, but the more full confirmation of other particulars, of which, though they do not lie altogether beyond our reasonings and our probabilities, the certainty is by no means equal to the importance. The true theist will be the first to listen to *any* credible communication of Divine knowledge. Nothing which he has learnt from Natural Theology will diminish his desire of further instruction, or his disposition to receive it with humility and thankfulness. He wishes for light; he rejoices in light. His inward veneration of this great Being will incline him to attend with the utmost seriousness, not only to all that can be discovered concerning Him by researches into Nature, but to all that is taught by a revelation which gives reasonable proof of having proceeded from Him.

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[104] There is assuredly nothing that more tends to absorb our whole faculties in devout admiration, than the contemplation of that universal power and pervading skill which is here remarked by the author. The same Being that fashioned the insect, whose existence is only discerned by a microscope, and gave that invisible speck a system of ducts, and other organs, to perform its vital functions, created the enormous mass of the planet thirteen hundred times larger than our earth, and launched it in its course round the sun,—and the comet, wheeling with a velocity that would carry it round our globe in less than two minutes of time, and yet revolving through so prodigious a space that it takes near six centuries to encircle the sun!—ENG. ED.

But, above every other article of revealed religion, does the anterior belief of a Deity bear with the strongest force upon that grand point, which gives indeed interest and importance to all the rest,—the resurrection of the human dead. The thing might appear hopeless, did we not see a power at work adequate to the effect, a power under the guidance of an intelligent Will, and a power penetrating the inmost recesses of all substance. I am far from justifying the opinion of those, who "thought it a thing incredible that God should raise the dead:" but I admit, that it is first necessary to be persuaded, that there is a God to do so. This being thoroughly settled in our minds, there seems to be nothing in this process (concealed as we confess it to be) which need to shock our belief. They who have taken up the opinion, that the acts of the human mind depend upon *organization*, that the mind itself, indeed, consists in organization, are supposed to find a greater difficulty than others do, in admitting a transition by death to a new state of sentient existence, because the old organization is apparently dissolved. But I do not see that any impracticability need be apprehended, even by these; or that the change, even upon their hypothesis, is far removed from the analogy of some other operations, which we know with certainty that the Deity is carrying on. In the ordinary derivation of plants and animals from one another, a particle, in many cases, minuter than all assignable, all conceivable dimension,—an aura, an effluvium, an infinitesimal,—determines the organization of a future body: does no less than fix, whether that which is about to be produced shall be a vegetable, a merely sentient, or a rational being; an oak, a frog, or a philosopher; makes all these differences; gives to the future body its qualities, and nature, and species. And this particle, from which springs, and by which is determined, a whole future nature, itself proceeds from, and owes its constitution to, a prior body: nevertheless, which is seen in plants most decisively, the incepted organization, though formed within, and through, and by, a preceding organization, is not corrupted by its corruption, or destroyed by its dissolution: but, on the contrary, is sometimes extricated and developed, by those very causes; survives and comes into action, when the purpose for which it was prepared requires its use. Now an economy which Nature has adopted, when the purpose was to transfer an organization from one individual to another, may have something analogous to it, when the purpose is to transmit an organization from one state of being to another state: and they who found thought in organization, may see something in this analogy applicable to their difficulties; for, whatever can transmit a similarity of organization will answer their purpose, because, according even to their own theory, it may be the vehicle of consciousness, and because consciousness carries identity and individuality along with it, through all changes of form or of visible qualities. In the most general case, that, as we have said, of the derivation of plants and animals from one another, the latent organization is either itself similar to the old organization, or has the power of communicating to new matter the old organic form. But it is not restricted to this rule. There are other cases, especially in the progress of insect life, in which the dormant organization does not much resemble that which encloses it, and still less suits with the situation in which the enclosing body is placed, but suits with a different situation to which it is destined. In the larva of the libellula, which lives constantly, and has still long to live under water, are descried the wings of a fly, which two years afterwards is to mount into the air. Is there nothing in this analogy? It serves at least to show, that, even in the observable course of Nature, organizations are formed one beneath another; and, amongst a thousand other instances, it shows completely, that the Deity can mould and fashion the parts of material nature, so as to fulfil any purpose whatever which He is pleased to appoint.

They who refer the operations of mind to a substance totally and essentially different from matter, (as most certainly these operations, though affected by material causes, hold very little affinity to any properties of matter with which we are acquainted,) adopt perhaps a juster reasoning and a better philosophy: and by these the considerations above suggested are not wanted, at least in the same degree. But to such as find, which some persons do find, an insuperable difficulty in shaking off an adherence to those analogies, which the corporeal world is continually suggesting to their thoughts; to such I say, every consideration will be a relief, which manifests the extent of that intelligent power which is acting in Nature, the fruitfulness of its resources, the variety, and aptness, and success of its means; most especially every consideration, which tends to show that, in the translation of a conscious existence, there is not, even in their own way of regarding it, any thing greatly beyond, or totally unlike, what takes place in such parts (probably small parts) of the order of Nature, as are accessible to our observation.

Again: if there be those who think, that the contractedness and debility of the human faculties, in our present state, seem ill to accord with the high destinies which the expectations of religion point out to us; I would only ask them, whether any one, who saw a child two hours after its birth, could suppose that it would ever come to understand *fluxions*;* or who then shall say, what further amplification of intellectual powers, what accession of knowledge, what advance and improvement, the rational faculty, be its constitution what it will, may not admit of, when placed amidst new objects, and endowed with a sensorium adapted, as it undoubtedly will be, and as our present senses are, to the perception of those substances, and of those properties of things, with which our concern may lie.

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* See Search's 'Light of Nature.'

Upon the whole; in every thing which respects this awful, but, as we trust, glorious change, we have a wise and powerful Being, (the Author, in Nature, of infinitely various expedients for infinitely various ends,) upon whom to rely for the choice and appointment of means adequate to the execution of any plan, which his goodness or his justice may have formed, for the moral and accountable part of his terrestrial creation. That great office rests with *Him*; be it *ours* to hope and to prepare, under a firm and settled persuasion, that, living and dying, we are his; that life is passed in his constant presence, that death resigns us to his merciful disposal.

APPENDIX.

ANALYTICAL VIEW OF THE RESEARCHES ON FOSSIL OSTEOLOGY, AND THEIR APPLICATION TO NATURAL THEOLOGY.—BY HENRY LORD BROUGHAM.

THE great work of Cuvier stands among those rare monuments of human genius and labor, of which each department of exertion can scarcely ever furnish more than one, eminent, therefore, above all the other efforts made in the same kind. In the stricter sciences, the 'Principia' of Newton, and in later times, its continuation and extension in Laplace's 'Mécanique Céleste,'—in intellectual philosophy, Locke's celebrated work,—in oratory, Demosthenes,—in poetry, Homer,—* leave all competitors behind by the common consent of mankind; and Cuvier's 'Researches on Fossil Osteology' will probably be reckoned to prefer an equal claim to distinction among the works on Comparative Anatomy. That this great performance deserves to be attentively studied, there can be no doubt. But as its bulk, in seven quarto volumes, may be apt to scare many readers, there may be some use in giving a general account of the progress of the author's inquiries, and of the principal results to which they led him, and more particularly in showing their application to Natural Theology.

Long before his attention was called to the remains of animals found in various strata of the earth, in more superficial situations, in crevices of rocks, and in caves, he had, fortunately for science, been a skilful proficient in anatomy, both human and comparative. But the first steps of his inquiries concerning those fossil remains, showed him how much he had yet to do, before he could implicitly trust the received accounts of the animal structures. As regards the human subject, for obvious reasons, the knowledge possessed, and which the ordinary works of anatomy contain, is accurate enough and sufficiently minute. But it is far otherwise with the structure of other animals, and especially as regards their Osteology. Of this Cuvier found so many instances, that he began his investigations with examining, minutely and thoroughly, the bones of all those species which, or the resemblances of which, were supposed to have furnished the materials of the great deposits of fossil bones, so abundant in almost every part of our globe. This, then, was the course which he invariably pursued; and he never attempted to draw any inferences respecting the fossil animal, until he had accurately ascertained the whole Osteology of the living species. There was obviously no other way of excluding mere fancy and gratuitous assumption from the inquiry, and making the science, of which he was really to lay the very foundation, one of pure reasoning from actual observation, in other words, one of strict induction.

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* If English Law were not a local learning merely, Fearne's work on 'Contingent Remainders' would perhaps deserve to be thus ranked. In the eloquence of the pulpit, Hall comes nearer Massillon, than either Cicero does, or Æschines, to Demosthenes.

In the course of his work, there are to be found striking examples of the mistakes into which former inquirers had been led, by neglecting this precaution. Partly by relying on incorrect, though generally-received, descriptions; partly by undervaluing the requisite comparisons of the fossil with the known bones; partly, no doubt, by giving loose to fancy, observing the remains discovered with the bias of a preconceived opinion, and making the fact bend to a theory, authors had committed the most grievous errors, hastened to conclusions wholly unwarranted by the facts, and often drawn inferences which the facts themselves negatived instead of supporting. Thus M. Faujas de St. Fond, a geologist of great learning and experience, but who had upon a very scanty foundation erected a dogma, that all the fossil remains belonged to animals still found alive in different parts of the earth, and set himself to deny the novelty of all the fossil species of unknown animals, conceived that he had at length himself found, among those remains, two animals which, if they still existed at all, could only be found in the interior and remote parts of India. Of these supposed discoveries he published the drawings, representing two fossil heads. But Cuvier, upon examination, found one of them to be exactly the auroch or bison, and the other the common ox.* A more skilful naturalist, Daubenton, describes three sets of fossil teeth, in the King of France's cabinet, as belonging to the hippopotamus ; and upon examination, two of these sets are found to be teeth of two new and unknown animals,† and the third alone those of the river horse ; and Camper, one of the greatest anatomists of his age, fell into a similar error. Upon the discovery of some fossil bones in the Duchy of Gotha, there was a general belief that they were some *lusus naturæ*, and several medical men wrote tracts to prove it. But a nearer inspection proved them to be elephants' bones.‡ The town of Lucerne took, in earlier times, for the supporters to its arms, a giant, from the opinion pronounced by a very celebrated physician, (Felix Plata,) that the bones discovered in that canton were human and gigantic, though Blumenbach afterwards examined them, and found they belonged to the elephant. Finally, Scheutzer maintained, that there were remains in different places of men who had perished in the general deluge, and supported his opinion by several instances to which he referred. Upon examination, these have proved to be none of them human bones ; but one set are those of a water salamander, while another belong to a newly-discovered animal still less resembling our species, being something between a lizard and a fish.§ When professional anatomists and professed naturalists could fall into such mistakes as these, there is little wonder that a statesman like Mr. Jefferson, however illustrious for higher qualities, should commit a similar blunder. He drew from the fossil bones discovered by General Washington near his seat in Virginia, and to which his attention was directed by that great man, the conclusion, that they belonged to an enormous carnivorous animal, which he named the Megalonyx. Cuvier, from a more correct examination, showed the creature to have been a sloth of large dimensions, and which fed wholly upon the roots of plants.

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* Recherches, vol. iv. p. 108.

† Ib. vol. i. p. 305.

‡ Ib. p. 120.

§ Ib. vol. v. pp. 433 and 451.

If these examples, and they might be very greatly multiplied, evince the necessity of a cautious examination, and of a previous attention to the Osteology of animals with which we are fully acquainted, the success of Cuvier's inquiries also shows that, with due care and circumspection, the reward of the inquirer is sure. The connexion between the different parts of the animal frame, is so fixed and certain, and the species run so little into one another, that it requires but a small portion of any animal's remains, to indicate its nature, and ascertain the class to which it belongs. Each small portion, so it be superficial, of bone—each little bony eminence—has its distinctive character in each species ; and from one of these, or sometimes from a piece of horn, or of hoof, or a tooth, the whole animal may be determined. "If," says Cuvier, "you have but the extremity of a bone well preserved, you may, by attention, consideration, and the aid of the resources which analogy furnishes to skill, determine all the rest quite as well as if you had the entire skeleton submitted to you."* Before placing entire reliance on such an induction, this great observer tried many experiments on fragments of the bones of known animals, and with a success so unvaried as gave him, naturally, implicit confidence in his method, when he came to examine Fossil Remains.

Among those he discovered a number of animals wholly unknown, and of which no individuals have existed since the period, when the authentic history of our globe and its inhabitants has been recorded. Out of the one hundred and fifty which he investigated, about ninety were either of new orders, or of new genera, or new species of genera still living on the earth. Considered in respect to genera, there were in the forty-nine unknown species, twenty-seven which belonged to unknown genera, and these genera amounted to seven. Of the remaining twenty-two, sixteen belonged to known genera or sub-genera; the total number of genera and sub-genera, to which he could reduce the whole of his fossil species, known or unknown, being thirty-six. It must, however, be added, that it is very possible the remaining sixty also may be of new species; for, as he only had the bones to examine, it does by no means follow, that the living animal did not differ as much from the ones which have the same Osteology, as the mule, or the ass, or the zebra do from the horse, the jackal from the dog, or the wolf from the fox; for the skeletons of a zebra, an ass, and a horse, present the same appearance to the osteologist; so do those of the jackal, the dog, the fox, and the wolf; and yet the same bones clothed with muscle, cartilage, skin, and hair, are, both to the common observer and to the naturalist, animals of a different species or subdivision. This consideration is to be taken into the account, as a deduction or abatement from the certainty which attends these researches; the certainty is only within certain limits; the fossil animals which now appear to resemble one another, because their osteology is the same, may have differed widely when living; those which appear to have been of the same class with other animals that yet people the earth, may yet have been extremely different; and those which now seem to be, in certain particulars, different from any we or our predecessors have ever known, may differ from all that live, or have lived on the earth we now inhabit, in many particulars far more striking than the varieties which their bony remains present to the osteologist's eye.*

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* Recherches, vol. i. p. 52. We have used the expression skeleton ; the author says animal, but manifestly, from what follows, this is incorrect.

The situations in which those remains were found, and are still to be met with, in greater or less abundance, are various; but they may be reduced to three classes in one respect, and to four in another: to three, if we regard only the kind of place where the bones are collected and found, in other words, their mineral matrix; to four, if we regard the periods at which the earthy formations were effected, and the bones of animals living then, or immediately before, were deposited. In the former point of view, the remains are found either, *first*, imbedded in strata, at greater or less depth, and of various kinds, and at various inclinations;—or, *secondly*, mixed together, and with earthy matter, in caves, and in rents or fissures or breaches formed in rocks;—or, *thirdly*, scattered more sparingly, and, as it were, solitarily, in alluvial soil or superficial detritus, in portions of the earth, apparently while it wore its present form, and was peopled by all or most of its present inhabitants. In the latter, and the more important point of view, those remains are either found, *first*, in the beds which were deposited by the waters of a world before the existence of either human beings, or the greater number of living genera of animals—as in the copper slate of Thuringia, the lias of England, the clay of Honfleur, and the chalk; in these strata the remains of reptiles are found with extinct species of marine shells, but no vertebrated animal higher than fishes;—or, *secondly*, in the strata deposited by the sea, after it had destroyed the first races, and covered the land they lived upon,—and in these beds, which at Paris lie on the chalk, are to be found only animals now extinct, and of which most of the genera, and all the species, differ from any we now see;—or, *thirdly*, in the strata deposited by the sea, or in fresh-water lakes,—and in these later tertiary beds are to be found animals now unknown, but resembling the present races; being different species of the same genera, or apparently of families still living, but not now inhabiting the same countries, or living under the same climates;—or, *fourthly*, in places where rivers, lakes, morasses, turf-bogs, have buried the remains of existing species; and as these changes of a limited extent have happened to the globe, constituted as it still is, those animals appear to have been, for the most part, identical with the animals which we still see alive, in various parts of the world, at least as far as their skeletons can tell.

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* Mr. C. once or twice adverts to this consideration; but he certainly does not bring it so prominently forward as would have been desirable.

Paris is the centre of a most extraordinary geological district. It is a basin of twenty leagues, between fifty and sixty English miles, in diameter, extending in a very irregular form from the Oise near Compiegne on the north, to the Canal de Lory, beyond Fontainbleau, on the south, and from Mantes on the Seine upon the west, to Montmirail on the east; comprehending within its circuit the towns of Paris, Versailles, Fontainbleau, Estampes, Meaux, Melun, Senlis, Nangis, and coming close to Soissons, Gisors, Beauvais, Montereau on the Yonne, Nogent on the Seine, and Condé; but not being continuous within these limits, for it is frequently cut off in islands, and every where towards the outline deeply indented with bays. This vast basin consists of six different formations, in part calcareous; but in some of which gypsum is so plentiful, that the quarries dug in it go by the common name of the Plaster of Paris quarries, and indeed gypsum has derived its common name from these. The lowest bed upon the chalk is composed of plastic clay, and it has covered both the plains and the caves of the district. This bed is full of fossil remains, very many of them belonging to unknown animals, and it also contains fragments of rock, which have come from a great distance. Above this bed is a layer of gritty limestone and shelly grit, of salt-water formation. Then come in succession, silicious limestone, fresh-water gypsum, and sand and grit without shells. The fourth formation is sandy, and of marine origin. The fifth has fresh-water remains and animals. The disposition of the land around and forming this basin, wears in all respects the appearance of having been broken in upon and hollowed out by a prodigious irruption of water from the southeast. Considerable corrections have since been made, especially as regards the second and third of these formations of Cuvier.

It appears that the base or bottom of the Paris basin, must have been originally covered with the sea. Different parts of the ground were then covered with fresh-water lakes, from which gypsum and marl were deposited, filled with the bones of animals that lived on their banks or in their islands, and died in the course of nature. After this deposition, the sea again occupied the ground, and deposited sand mixed with shells; and when it left the land dry for the last time, there were for a long while ponds and marshes over the greater part of the surface, which thus became covered with strata containing fresh-water shells, the base of those strata consisting of a peculiar stone found in fresh water, and occurring in many parts of France. The fossil remains in this great basin exhibit little variety of families; and the vegetable remains show, that the plants were confined to palms, and a few others now unknown in Europe. As the great continents, which offer a free communication throughout, are inhabited by a great variety of animals, while New Holland and the other islands in the South Seas have only a very few, and these almost all of the same family, we may conclude, that the land forming the Paris basin was originally surrounded by the sea.

The deposits in the rents or fissures of the strata may now be briefly mentioned, and they present a very singular subject of contemplation. They are found all around the Mediterranean, at Gibraltar, Cette, Antibes, Nice, Pisa; in Sicily, Sardinia, and Corsica; at the extremity of the kingdom of Naples; on the coast of Dalmatia; and in the island of Cerigo. The body of the deposit is calcareous, and of the same kind in all these gaps or fissures. The same, or nearly the same, bones, are every where found imbedded in it; they are chiefly the bones of ruminating animals; and besides those of oxen and deer, there are found those of rodents, a kind of tortoise, and two carnivorous animals. In these fissures, there are many land but no sea shells; and the matter that fills them is unconnected with other strata. It follows from the first fact, that they must have been consolidated before, and at the time when, the sea came over those countries and deposited shellfish in the other strata; and from the second fact it follows, that they must have been formed when the rocks, in the rents of which they are found, were already formed and dry. Hence these fissure deposits are modern, compared to the strata which were formed at the bottom of the sea and of lakes. Nor does any operation now going on upon our globe, bear the least resemblance, in Cuvier's judgement, to that by which those deposits must have been made. Upon this, however, great controversy has arisen among his successors.

It was necessary that we should shortly advert to the places where, for the most part, these fossil remains are found; in doing so, we have anticipated a few of the conclusions deduced from the consideration of the whole subject. We are now to see what results were afforded by Cuvier's careful examination of the remains, which he instituted after he had with equal care ascertained the exact Osteology of the living animals, in each case where the fossil remains appeared to offer a resemblance with existing tribes.

The *first* part of Cuvier's researches is occupied with the *pachydermatous** animals whose remains are found in alluvial deposits.

The *second* part consists of two subdivisions; in one of which are given minutely the whole details of the Paris basin; in the other subdivision the examination of the animal remains, beginning with the pachydermatous, and then the others that accompany them, whether quadrupeds, reptiles, fishes, or birds. So that the Paris basin is made the ground of this arrangement, and its Fossil Zoology is gone through, without much regard to the general arrangement of the rest of the work.

The *third* part is occupied with the *ruminant* animals, unless in so far as one of its subdivisions, treating of the gaps or fissures of the Mediterranean, also treats of the few other animals which are there found besides the ruminant.

The *fourth* part, is occupied with *carnivorous* animals; the *fifth*, with *rodents*; the *sixth*, with *toothless* or *edentate* animals; the *seventh*, with *marine mammalia*; the *eighth* and last, and perhaps the most interesting of the whole, with *reptiles*; including the anomalous species newly discovered, which partake of the nature at once of the reptile and fish, or of the reptile and bird.

As no arrangement is yet made of these fossil animals, under any of the heads which we have stated, we are at liberty to adopt any order that may appear most convenient; and we shall accordingly begin with those, which at first appeared to resemble the known species of the rhinoceros, the hippopotamus, and the elephant, and which a careless observer would unquestionably have confounded with these animals; but they were soon ascertained to be different.

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* *Animals with thick skins, as the elephant, horse, hog.*

I. Of the fossil rhinoceros four distinct species have been found;* and they are all distinguishable from the four known kinds of rhinoceros—those of India, Java, Sumatra, and the Cape. The fossil animal had a head both larger and narrower than the living kinds, and much larger in proportion to his body. He was also much lower, and a more creeping animal. He, for the most part, had either no incisive teeth or very small ones, but one species had these of a good size. One of the fossil species is distinguished from all the four known ones, and from the other three fossil ones, by a still more marked peculiarity; his nostrils are divided from each other, not by a gristly or cartilaginous, but by a bony partition, whence the name of *Tichorhinus*† has been given to him, the three others being termed *Leptorhinus*,‡ *Incisivus*, and *Minutus*.

The grinding teeth of the Tichorhinus are also found to have a peculiarity, which no other teeth either of any living or any fossil animal have. They are indented at the base, in one of the ridges, after being worn down by use. This, as well as the bony partition, affords, therefore, the means of discovering the species. The use of the partition apparently was, to support the weight of two large and heavy horns on the nose.

The history of the first of these species, the Tichorhinus, furnishes a remarkable example of the errors into which even able and expert observers may fall, when they make more haste than good speed to reach a conclusion. A missionary named Campbell having sent home the head of a rhinoceros, being one of several killed close by his residence, and well known to have been so, Sir Everard Home compared it with a fossil head from Siberia, sent by the Emperor of Russia to Sir Joseph Banks; and finding, as he thought, that it was of the same species, he very rashly inferred, that the position which affirms the existence of unknown animals among the fossil remains, was much weakened by this supposed discovery. Cuvier made a more accurate comparison, and found that the Cape scull was materially different from the fossil one, but resembled the head of the existing species, which Sir Everard Home had also denied. The most remarkable omission, however, of the latter was, his never looking to see if there existed a bony partition between the nostrils. This Cuvier did, and found it cartilaginous and not bony. So that the most singular of the new and unknown fossil animals belonging to this class remained still a novelty, even if Sir Everard Home had been correct in all the comparative examinations which he ever did make; and his conclusion of fact from that comparison, even if admitted to be well founded, had no bearing whatever upon the general position against which he had pointed it.

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* Of these there are now nine species, five having been discovered since Cuvier's work.

† *From* Τειχος, a wall.

‡ From Λεπτος, slender.

The extraordinary fact, of a portion of one of these ancient and lost animals' muscular substance and skin having been found, is further to be mentioned. In a block of ice on the banks of the Wilujii, a river of Siberia, there was discovered this huge mass of flesh, about the year 1770. It was found to have longish hair upon parts on which the existing rhinoceros has only leather; consequently, it must have lived in a colder climate than the present animal inhabits. But it appears to have been killed by some sudden catastrophe, and then to have been immediately frozen, else it would have undergone decomposition, like the other remains of which the bones alone are left.

There are two species of living elephants, the African and the Asiatic; the former distinguished from the latter chiefly by the length of his tusks, by a peculiar disposition of the enamel in the jaw teeth, and by never having been tamed, at least in modern times. The fossil elephant resembles the Asiatic species most, but differs in some material particulars. It has long tusks, sometimes exceeding nine feet in length; the jaw teeth are differently set; the under jaw of a different shape, as well as other bones; and from the length of the socket bones of the tusks, the trunk must have been also very different. These remains* are found in great abundance both in Europe and in America, in neither of which parts of the globe are there now any living elephants of any species produced. In the same strata and caves, other animals are also found, both of the known and extinct classes: and occasionally, shells also. The elephant's bones are chiefly discovered on plains of no considerable elevation, and near the banks of rivers. They never could have been transported by the sea over the mountains of Tartary, upwards of twenty thousand feet in height, which separate Siberia from the parts of Asia where the elephant now flourishes. It must be added, that, besides those bones, a still more perfect specimen of the softer parts has been preserved, by the action of cold, than we have of the rhinoceros. In the same country, near the mouth of the river Lena, a mass of ice was found, in 1799, by a fisherman, which he could not break or move; but in the course of the next summer it partially melted, when it was found to contain an entire elephant frozen. The neighboring Tartars with their dogs, and afterwards the bears, destroyed the greater part of the flesh, but the skin and bones were saved. It was found to have hair, and even woolly hair or fur, upon different parts of the body. It must then have been calculated, like the animal of the Wilujii, for living in a climate much colder than that of India or Africa, and, like that rhinoceros, it must have been frozen immediately after its death. Its tusks were circular, and nearly ten feet long.

Of the hippopotamus, two species† have been found among the fossil bones, both so different from all living animals, that every bone of each differs from any other known bone; so that even if an error should have been committed in connecting the different bones together, there must be not only two, but more than two, new species thus discovered. These animals abound in the great deposit of fossil bones in Tuscany, in the valley of the Arno, and at Brentford, in Middlesex. There are two other fossil species, of which, however, less is known; one of these is very small, not larger than a common hog.

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* There are now known eight species of this fossil elephant.

† Two more species have since been found.

Three pieces of a jaw-bone, with some fragments of teeth, have been found in Siberia, which, upon examination, prove to have belonged to a singular species, resembling both the rhinoceros and the horse, and forming probably the link between these two animals. The size is larger than the largest fossil rhinoceros. The discoverer, Mr. Fischer, has named it the *Elasmotherium*,* from the thin enamel plate which winds through the body of the tooth in a peculiar manner.

But much more is known of a lost species which approaches the elephant, although differing in some important respects both from the living and the fossil elephant. The most remarkable difference in the osteology is presented by the jaw teeth, which have the upper surface mamellated or studded with nipples; from whence Cuvier named it the *Mastodon*.† When these tubercles are worn down by use, the surface of the tooth has a uniformly plane or uniformly concave surface. The structure of the vertebræ shows it to have been a weaker animal than the elephant; and the belly was considerably smaller. The lower part of the fore leg was longer, and the upper joint shorter; the shoulder one ninth shorter too. The pelvis was more depressed; the tibia and thigh-bones materially thicker; and the body a good deal longer in proportion to the height. As it fed upon vegetables, and had a short neck and feet unfit for living in the water, it must have had a trunk; and it also had tusks. It seems to have fed upon the softer parts of vegetables, and to have inhabited marshy ground. Six species‡ have been discovered of this animal, chiefly differing from each other in the teeth; and of these six, two only are well known.

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* *Ελασμος*, thin plate.

† Or Mastodonte, which is sometimes, but unnecessarily, rendered by Mastodonton: *μαστος*, mamilla.

‡ Five more species have since been discovered.

The mastodon was long supposed to be peculiar to America, and was sometimes called the Ohio animal; but there have since been found teeth in different parts of Europe, evidently belonging to the two better-known species; and the other four kinds are, to all appearance, European.

In the same strata with the remains of elephants, rhinoceroses, and other animals both of extinct genera and species, are almost every where found the bones and teeth of horses, very nearly resembling those of the animal now so well and universally known. It yet happens, that for want of due attention to a branch of anatomy more familiar to us than any except the human, naturalists have constantly fallen into error in examining fossil bones. Thus Lang, in his history of the figured stones of Switzerland, took a horse's tooth for a hippopotamus's; and Aldrovandinus in one work describes teeth of that class as giants', and in another as horses'; while several authors have confessed, that they could not tell to what tribe such remains had belonged. Cuvier did not, therefore, deem himself released from the duty of fully examining the common horse's osteology, merely because of the frequent and minute descriptions which had previously been given of it; and his intimate acquaintance thereby obtained with the nature of every bone and tooth, has enabled him to pronounce with confidence upon the existence of horses like our own, among the unknown animals which inhabited the earth, before the vast revolutions that changed both its surface and its inhabitants. He has, however, justly noted the fact, that there is no distinguishing the bones of the horse, the ass, the mule, and the quagga; so that very possibly these remains may have belonged to any of those animals; and very possibly also to none of them, but to some fifth species, now, with the mastodon and other contemporary animals, extinct. The same remark is of course applicable to the bones of the hog and the wild boar, found occasionally among other fossil remains.

The tapir family in many important particulars resembles the rhinoceros; and there are often found in the same tertiary strata with the rhinoceros, elephant, and mastodon, several species now wholly extinct, but allied to the tapir. Two of these must have been of prodigious size, the largest nineteen and a quarter feet long and nearly twelve high.* But there are other species, to the number of twelve at least, whose size differs little from that of the tapir; the bones are somewhat different, however, and particularly the teeth, which, from the eminences or ridges upon them, Cuvier made the ground of the genus to which he gave the name of *Lophiodon*.† It is in different parts of France that all these species were first found; the smaller ones always in strata of fresh-water shells, and in company with remains of either unknown land animals, or crocodiles and other river animals now found in hot climates; and in several places, the strata in which they occur, have been covered over, after they had been deposited and their bed consolidated, with strata of an origin unquestionably marine. By far the greater part of fossil remains, both those which have been already described, and those which we are afterwards to consider, have been found in sandy, or calcareous, or other earthy strata. But some few are also found in imperfect coal or lignite. In the part of the Appenines where that range meets the Alps, there is a tertiary coal stratum, and in it have been found two new genera of pachydermatous animals, and a third in the fresh-water deposit near Agen. Cuvier calls these *Anthracotheria*.‡

The general conclusion, which is to be derived from the important branch of the inquiry of which we have been analyzing the resulting propositions, is partly zoological, and partly appertains to geology. The former portion of it is, that more than thirty kinds of land animals have left their fossil remains in the strata now forming dry land, but deposited under water; that, of these, seventeen or eighteen§ are now extinct, and have been wholly unknown since the earth was peopled with its present inhabitants, six or seven being of a genus now unknown, the others being new species of known genera; that twelve or thirteen kinds have, as far as their bones are concerned, the appearance of having belonged to the species which still inhabit the globe, although their identity is far from certain, depending only upon the similarity of their skeletons; and that animals of genera now almost confined to the torrid zone, used formerly to inhabit high and middling latitudes. The geological portion of the conclusion is, that some of these fossil remains have been buried by the last, or one of the last revolutions, to which our planet has been subjected, as they are in loose and superficial strata, whilst other remains in the tertiary strata appear generally to have come from deaths in the course of nature, though some of these too must have perished by a sudden revolution.

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* This is now better known, and is called the *Dinotherium*.

† *Λοφιον*, a small hill, eminence, or ridge.

‡ *Ανθϱαξ*, coal. Of these seven species are now known.

§ According as the Elasmotherium is allowed to be sufficiently distinguished or not.

II. The Paris basin presents, in great abundance, the remains of herbivorous, pachydermatous animals of two distinct genera, each comprehending several species, and all alike unknown in the living world. The animals to which some of them approach the nearest, are the tapirs; but they differ even generically from these, and from every other known tribe. The inquiry into which Cuvier entered for the purpose of ascertaining to which set of bones each particular piece belonged, so that he might be able to restore the entire skeletons by putting together all the parts of each, was long, painful, and difficult in the highest degree. He had first to connect the two bones of the hinder feet together, in each instance, by minutely examining the relation of the pieces to one another; and this process could only be conducted by deriving light from the analogies of other and known animals. He then had the different bones of the fore feet in like manner to put together, in order to restore those fore feet. Next the hinder and fore feet of each animal were to be connected together. Afterwards he had to mount upwards, and connect the bones of the body with the several feet. The teeth and head must next be referred to the limbs. Then the vertebræ and then the trunks were to be restored; and then other bones, not yet accounted for, were to have their places found. The result of this most elaborate and perplexing investigation, the details of which occupy the fifth part of a large quarto volume, and are illustrated by between sixty and seventy admirable plates, containing between six hundred and seven hundred figures of bones, fragments of bones, and congeries of bones, may be stated shortly thus :—There are of the first genus, which he denominates *Palæotherium*,[*] six, or perhaps seven, species,[†] principally distinguished by the teeth and the size, as far as the bones are concerned, but which, probably, were much more widely different when alive. One of these resembled a tapir, but was only a foot and a half in length, being about the size of a roebuck. Another was nearly three feet high, and the size of a hog. A third was between four and five feet in height, and about the size of the horse or the Java rhinoceros. It had feet thicker than a horse's, and a larger head ; its eyes were very small, its head long, and it had a snout protruding much over its under jaw and lip. In a specimen of one of these species, the first now mentioned, there were actually found some of the animal's softer parts, certain flexible filaments, which, upon being burnt, gave an animal smell, and were manifestly portions of the nerves or blood-vessels. Besides these three species, three, and possibly four others, were distinguished, one the size of a hare.

The other genus was termed by Cuvier *Anoplotherium*,[‡] and of these, two species, at the least, are distinguishable.[§] The first, or *common* anoplotherium, is about the size of an ass, being four or five feet high, and its body four feet long, but with a tail of three feet long ; it was probably an animal that lived partly in the water, as it appears made for swimming like an otter. But it has a peculiarity of structure which is to be found in no other animal whatever ; its feet are cloven, but have two separate and distinct metacarpal and metatarsal bones, which are soldered together in other animals ; it has also its teeth contiguous, while all other animals except man, have them apart. The other species, or *secondary* anoplotherium, resembles the former, but is only the size of a common hog. But besides these anoplotheria properly so called, four other cognate species are found, one of the size and appearance of a gazelle, one the size of a hare, and two of the size of a guinea pig. A curious specimen gives the very form of the anoplotherium's brain, a cast of it remaining in the earthy mass. Its size is extremely small, and Cuvier infers from this that the animal was exceedingly stupid.

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[*] *Παλαιος*, ancient ; *ϑηϱιον*, wild beast.

[†] Eleven species are now known. [‡] *Ανοπλος*, unarmed, without tusks.

[§] Six species are now ascertained.

All these animals are found in the Paris basin; but bones of the palæotherium have been discovered elsewhere, namely, at Orleans, Aix in Provence, Montpelier, and Isell. As the specimens from those other places were extremely rare in Cuvier's time, he could not have the same certainty respecting them as from the more copious collections obtained in the Paris district. But he could distinguish at least three different species.

Besides these two new genera, the palæotherium and anoplotherium, the Paris basin affords two other new genera of pachydermata, the one, called *Chæropotamus*,* resembling animals of the hog kind—the other, *adapis*, very small, being about a third larger than the hedgehog, which it also resembled in structure. There are found, too, the remains of five or six kinds of carnivorous animals, one of them being of enormous size, and resembling a tiger. Another has projecting bones to support a bag or purse, as in the kangaroo kind; but it is of a genus of marsupial animals now found only in America, being a sort of opossum. The basin, besides, affords a considerable number of tortoise remains, some fish bones, and even perfectly complete skeletons of fish, and ten species, at least, of birds, all now unknown, but one of which resembles the Egyptian ibis. It is very remarkable, that in one specimen, brought to Cuvier while his work was printing, the windpipe was preserved, and the mark or mould of the brain appeared upon the surface of the gypsum.

III. Of ruminating animals, the fossil deposits present many remains. There are of the deer, besides divers that closely resemble known species, no less than twelve* species wholly unknown among the existing inhabitants of our earth. One has enormous horns, six feet from tip to tip, and of this animal we know nothing among existing species, though it comes nearest the elk. Two kinds are somewhat like roebucks, and of that size. The fissures of the Mediterranean give six new species,† of which that found at Nice is like an antelope or a sheep.‡

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* There are now three species known.

None of our common oxen are found in a fossil state, unless in morasses or peat bogs, where they have certainly been buried while the globe's surface was in its present condition, and peopled as we now find it. But animals of the same genus certainly existed in the age of the elephant and rhinoceros, and of the extinct species.§ There prevails no small uncertainty as to the identity of the fossil bison and musk buffalo, with the living species of the former in Europe, and of the latter in America; but the remains which have been found of a kind of ox, appear different from any known species, and it appears that no buffalo resembling either that of the East Indies, or that of the Cape, has been found in any place.

The conclusions, both zoological and geological, from this part of the investigation, and from the examination of the remains found in the Paris basin, in every respect tally with those to which we were led by a consideration of the pachydermatous remains under the first head of the inquiry.

IV. There are found in caverns both in France, Germany, Yorkshire, and Devonshire, and in the fresh-water formation of Val d'Arno, in Tuscany, the remains of many animals, some extinct, and others no longer inhabitants of the same temperate latitudes, but confined to the frozen and the torrid zones. By far the greater part of these animals belong to the carnivorous class, except in the Yorkshire caves, where many of the herbivorous kind are also to be found. In the foreign caves the bear is the most numerous, and presents extinct species. In the Yorkshire caves, (at Kirkdale,) the hyæna predominates. In the German caves, hyænas are comparatively few, and in Val d'Arno not more numerous. In Kirkdale, there are very few bears. The race of lions and tigers is much more rare than any of the others. Not above fifteen have been found in Germany, while there have been found hundreds of bears; and in Yorkshire, where hyænas abound, very few lions and tigers are traceable. Of the wolf and fox, some are found, but not so many in Yorkshire. There is also a very large kind of dog traced, which must have been five feet in height, and eight in length from the mouth to the tail.

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* No less than twenty-eight species are now known.

† In the Résumé to Parts III. and IV., Cuvier says, "Of the six deer found in alluvial deposits, one with large horns is entirely unknown; of the four in fissures, three are unknown, at least in any but most distant countries. Another, that of Orleans, is quite unknown, as are the two species of lagomys found in the fissures."

‡ A thirteenth new species was at one time supposed to have been found in the Swedish province of Scania; but Cuvier, before the last volume of his work was printed, had reason to believe that this animal belonged to one of the tribes formerly known, and still living in the north of Europe.

§ Of these there are now seven ascertained.

Of bears, it appears, after a very close examination, that there are found, at least, two species* larger than those now known; and a third, which, both in size and other particulars, so nearly approaches the common bear, that Cuvier does not regard it as a new species. But it seems as if the one found in Tuscany formed a third kind of animal now extinct.

The hyæna† is found not only in the caverns and other quarries where the bear abounds, but also in the alluvial strata with the elephants and rhinoceroses. In Kirkdale cave his dung has been distinctly recognised by a comparison with that of living hyænas; and the particular crack which he makes in the bones of the beasts devoured by him, to get at the marrow, has, in like manner, been identified by actual comparison. Nevertheless, the fossil animal differs from the living one in some material respects, particularly in size, and in having his extremities both thicker and shorter. The caverns contain two species‡ of a huge animal of the felis (or cat) kind, considerably larger than the lion or the tiger, besides some few resembling living species in size. One is between one eighth and one ninth larger than the lion, and has its trunk more convex in the lower outline. A new, but smaller, species of the felis kind is also found in the Mediterranean fissures.

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* Seven more have since been added.

† Now eight species. ‡ Now fifteen.

In the dog tribe, there has been found a wolf or dog,* but more probably the former, which differs, though slightly, from any known species, in having the muzzle shorter in proportion to the scull; and also a species has been observed, clearly new, of the same genus. We as yet only know of it by two of his jaw teeth, found at Avaray, near Beaugency. He must have been eight feet long and five high. The Paris basin affords, likewise, another new species of the dog kind, but not materially varying in point of stature. The common fox, however, is found, and also the dog and wolf, in the caves.

The caves afford a considerable number of bones of the weasel and glutton,† closely resembling the existing species. The latter animal is only known now in the higher latitudes; but in the caves we find his remains mixed with those of animals belonging to the temperate and the torrid zones.

It is thus shown, by the inquiries which comprise the third and fourth part of this great work, that the former inhabitants of these regions were wholly different from the present population. Even the animals of hot climates here found, and referable to existing genera, must have differed entirely from those species which survive in the torrid zone, because they could exist in a temperature now wholly foreign to their nature. The reindeer and the lion, the sloth and the elephant, all found in the same places, show that the climate of those latitudes remains nearly the same, but that their inhabitants have been changed.

In all these researches one blank is immediately perceptible. There are not only no human remains whatever, but there are none of apes, or of any of the genus of quadrumanes. Animals far less in size, and whose bones would much more easily have perished, as rats and mice,

* Ten species are now known.

† Of the fossil gulo two species are now ascertained.

have left their skeletons with those of the largest beas but of the monkey tribe no vestige whatever is to be d covered; and the conclusion is inevitable, that the str were deposited, the fissures filled, the caverns strew with bones, at an age anterior to the existence of th tribe, as well as to the creation of our own species. Th it was when Cuvier wrote.*

V. Besides the animals of the *Rodent* description, fou in the Paris basin and the Mediterranean fissures, rabbit lagomys, field mice, there are several others in the alluvi strata and caverns, some apparently of known, and othe certainly, of unknown kinds. The hare has been trace at Kirkdale; the beaver near the Rhine; two new *specie* of the beaver near Rostoff, in the south of Russia; *anothe* species, also unknown, at Œningen.

VI. The toothless or *Edentate* animals, afford so varieties still greater than those to which our attention h as yet been directed. None of the known species of this tribe are to be found in any of the strata, fissures, or cave in Europe. But three genera entirely new, with two of which, at least, there are ample materials for becoming acquainted, have been found in America, and these are deserving of our best attention.

The first is the animal named by Jefferson, from the size of his feet, or rather what he supposed claws, the *Megalonyx*,‡ and respecting which he fell into an error as we formerly stated. Cuvier preceded his examination of this, as of all other animal remains, by a thorough investigation of the osteology of living animals of this family; and it is the result of his careful inquiry that the bones found in America and described by Jefferson, and of which both casts and drawings were sent over, as well as a tooth, belonged to an animal of the sloth tribe, but wholly new and now quite extinct. The tooth was cylindrical, and rn down on the top, but cased round with enamel like e sloth's, and not at all like a cat's. In the paw, the second phalangal bone was symmetrical. This bone is curved and not symmetrical, in animals that raise up and draw back the claw, as all the cat kind do. The first phalangal bone, too, was the shortest; whereas the lion, and others of the cat kind, have that bone the longest. But from the known species of sloth it differs most strikingly in its stature, which was equal to that of the largest oxen, those of Hungary and Switzerland, and a sixth larger than the common kind.

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* This refers of course to the state of discovery in Cuvier's time. There are remains of the monkey said to have been lately discovered in the South of France, and in the Himmaleh Mountains; it is said, also at Calcutta. But the proofs are not clear.

† Now four are known, and three of lagomys.

‡ Two species are now known.

The second of these new animals has been termed *Megatherium*, from his great size, and the remains are found in South America. From his teeth it appears that he lived on vegetables, but the structure of his very long fore paws and nails, shows that it was chiefly on the roots. He possessed also good means of defence, and so was not swift of foot. His covering seems to have been a thick and bony coat of mail, like the armadillo's. His length was near thirteen feet and a half English, and his height about seven feet and a half. From the sloth he differs not only in size, but in other particulars; for example, his fore legs are much nearer the length of his hinder legs than in the sloth, which has the former double the latter. But, on the other hand, the thickness of the thigh-bone in the megatherium, is much greater than in any of the known sloth tribe, or indeed any other animal either known or extinct; for the thigh-bone is about half as thick as it is long.

The third of these new animals, was known to Cuvier only by one fragment which he examined. It was a toe; and from a careful discussion of its form and size he inferred, that the animal belonged to the edentate tribe of Pangolins, and that, if so, its length must have been twenty-four feet, (twenty-six English,) and its height in the same enormous proportion. The bones were found in the Palatinate, near Eppelsheim.*

VII. The course of our analysis has now brought us to the family of the ***Sea Mammalia***, and these supply new food for wonder. So different from the bones of any living animals, are those remains which have been examined, that a new genus is formed consisting of several species, and bearing the same relation to the cetacea, or animals of the whale tribe, that the mastodon, palæotherium, and anoplotherium do to the pachydermata, or that the megalonyx and megatherium do to the edentata. He terms the genus *Ziphius*, from its having a sword-like head. One of these was found near the mouths of the Rhone. The dimensions are not given by Cuvier, but from the drawing the head appears to have been about three feet in length. The remains of a second species of ziphius were found thirty feet under ground at Antwerp, and between nine and ten under the level of the sea at low water. The head is considerably larger than that of the first-mentioned species. The head of a third species is found in the museum at Paris, but with no account of its history.

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* Subsequent discoveries have made it probable that this toe belonged to the Dinotherium.

Besides this new genus, there are other cetacea of new species discovered among the fossil bones. At Angers, a Lamantin of an extinct species has been traced. The remains of a dolphin, which must have been twelve or thirteen feet long, and different from all the known species, have been found in Lombardy. In the Landes, another dolphin, which must have been nine or ten feet in length, has been discovered. A third kind of dolphin, different from any now living, has been found in the department of L'Orne, while a fourth, also found in the Landes, nearly if not wholly resembles the ordinary dolphin. In Provence, a cetaceous animal of an unknown species is found, somewhat like the hyperodons.

In the neighborhood of the Ochill hills in Scotland, the fragments of a whale's bones have been found in a recent alluvial stratum, at only eighteen inches depth, with a part of a deer's horns near. It must have been a whale of some size, as the vertebræ were eighteen inches broad, and one of the ribs ten feet long. But it is most probably one of a kind still existing in our seas, from the place where it was found.

In the mountains near Piacenza, there have been found the bones of a small whale. Its length was near twenty-three feet, and its head was near six feet and a half long. The place where these bones lay, was a clay stratum with numberless shells all round, and oysters clinging to the bones. This animal was in a tertiary formation, six hundred feet above the plain of Italy. It appears to be of a new species.

In the very heart of the city of Paris, have been found the bones of another whale, far larger, and of a species wholly unknown. Its head must have been fifteen or sixteen feet long, and its body fifty-four or fifty-five. It was found in a compact sandy bed in digging under the cellar of a wine-merchant.

The conclusion to which these Researches unavoidably lead, is that the earth, in its former state, did not differ more widely in the races which inhabited it, than the sea did—that ocean, which was itself the great agent in producing many of the changes, that have at various times swept away one race of living creatures from the surface of the globe, and mixed up their remains with those of animals engendered in its own bosom.

VIII. We have now reached the last and the most singular portion of these Researches ; the examination of the *Reptiles* whose relics are found in many of the stratified rocks of high antiquity.

In the calcareous schist, near Monheim, whence the stones used in lithography are gotten, a new species in the crocodile family is found, whose length must have been about three feet. At Boll, in Wirtemberg, another, apparently of the same kind, has been discovered. At Caen oolite quarries, a different and equally unknown species is traced ; its body is between four and five feet long, and its whole length thirteen. Others of this family have been found in the Jura, and there they are accompanied by the fresh-water tortoise. At Honfleur, another species is found, and the remains of two other unknown kinds have been discovered near Harfleur and Havre.

Besides the remains of crocodile animals found in these more ancient strata, there are many also found in the more *recent beds, where* the bones of the palæotheria and lophiodons are deposited. The Paris basin, the marl pits of Argenton, Brentford, and other places, have furnished these specimens. But whether they were of different species from those new ones found at Monheim, Caen, and Honfleur, the examination which they had undergone in Cuvier's time was too imperfect to determine. They have since been shown to be different.

It deserves to be remarked of the new species of crocodiles, that their difference from the known kinds, exceeds in manifest distinctness that of almost any other animals which are of the same genus, and do not differ in size; for the vertebræ, instead of being, as they are in the crocodiles now alive, concave in the front and convex behind, are convex in front and concave behind. This at once furnishes a very triumphant answer to those doubts which have been raised as to the novelty of the species, and still more signally discomfits the speculations of those,' who fancy that the differences perceived in fossil bones have been caused by change of temperature or of diet, or by the passing from the living to the petrified state.

The examination of fresh-water tortoises, of the genus trionix, whose remains are found in the plaster quarries and other strata, offers similar results. Thus at Aix, in Provence, a trionix of a new species is found. Another species, also new, is found in the Gironde ; and two others have been traced, less distinctly, in the gravel beds of Hautevigne (Lot et Garonne) and of Castelnaudary.*

Fossil fresh-water tortoises, of the genus emys, give the same results. They are found in the molasse of Switzerland, in the Sheppy clay near London, and in the limestone ridges of the Jura.

Fossil sea tortoises offer the like appearances. One of an unknown species is found near Maestricht, the genus being still living in the sea, and familiar to our observation. So that, altogether, the examination of tortoise remains leads to the same inferences of islands having existed in the ocean at a former period, inhabited chiefly by reptiles or oviparous quadrupeds, and before the creation of any considerable number of the viviparous orders.

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* Eight species have now been traced.

As we proceed towards the close of these Researches, the subject rises rather than falls off in curiosity and interest. We now come to the family of lizards, by which is here understood all the old genus of Lacerta, (Lin.,) excepting the crocodile and salamander tribes.

In the celebrated fossil fish deposits of Thuringia, are found the remains of a monitor, of a species somewhat varying from the known species in two particulars, greater elevation of the vertebral apophyses, and a longer leg in proportion to the thigh and foot. Remains of a similar aspect, occur in France near Autun, and in Connecticut in North America.

In the strata of fine and granular chalk near Maestricht, between four and five hundred feet in thickness, are found the remains of a huge reptile, which Mr. Faujas represented as a crocodile, following the opinions of the people in that neighborhood; but so celebrated an anatomist as Adrian Camper was not to be thus deceived, and he proved it to be an animal of a new genus, related to the monitor, and also to the iguana; it seems to be placed between the fishes on the one hand, and the monitors and iguanas on the other. But the size constitutes its most remarkable difference when compared with these. They have heads five or six inches long; his was four or five feet, and his body fifty. He was therefore a lizard exceeding the size of a crocodile; just as the extinct tapir was the size of an elephant, and the megalonyx was a sloth the size of a rhinoceros. It appears that, like the crocodile, he was aquatic and could swim; and that his tail was used as a scull, moving laterally in the water, and not up and down like the cetacea, an order to which the elder Camper at first rashly referred him.

In the canton of Meulenthal, at Monheim, ten feet below the surface, and near some kinds of crocodile remains, bones were discovered of another unknown sub-genus of the order Saurus, and which Cuvier calls Geosaurus, and places between the crocodile and the monitor. It was apparently twelve or thirteen feet long, that of Maestricht being fifty.

A large animal of this family, is found to have been an inhabitant of the same ancient world. At Stonesfield, in the neighborhood of Oxford, Dr. Buckland discovered his remains, in a bed of oolitic calcareous schistus, under a solid rock of forty feet thick. The thigh-bone is two feet eight inches in length, which would seem to indicate a body in the whole forty-five feet long. But even if his tail were not in the proportion of the lizard's, as this calculation assumes, his length must be, according to the crocodile's proportions, thirty feet. This animal approaches the geosaurus of Monheim, and also, in other respects, has some affinity with the crocodile and monitor; but in size he greatly exceeds the crocodile, and comes nearer the whale. His voracity must, from his teeth and jaws, have been extreme. He was also an amphibious animal; for his remains are surrounded with marine productions. The genus has been called *Megalo-saurus*. Teeth and bones of the same genus have been since discovered in Tilgate Forest, Sussex. Mr. Mantel has found, in the same place, the thigh-bone of a much larger animal. Other reptiles have been found in the Muschelkalk quarries near Luneville.

But there are animals of the family of saurus yet more strange, if not for their size, at least for their anomalous structure and habits. A reptile is found of a genus so extraordinary, as to comprehend within itself the distinguishing nature both of the lizard and the bird. It has a very long neck, and the beak of a bird. It has not, however, like a bird, wings without fingers to strengthen them; nor has it wings in which the thumb alone is free like a bat; but the wings spread by a single long finger, while the other fingers are short, and with nails like the fingers of ordinary apterous (or unwinged) animals. From these circumstances, Cuvier has named this genus* the *Pterodactylus*.† It was first discovered by the late Mr. Collini, a Florentine, settled at Manheim, and formerly attached to the family of Voltaire, of whom he published some memoirs. The skeleton, nearly perfect, was found in the marly stone-beds of Aichstadt, in the county of

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* There are now ten species observed.

† *Πτεϱον*, wing; δακτυλος, finger.

Pappenheim; but Mr. Collini fell into very great mistakes respecting the genus of the animal, which he supposed to be of marine origin, from not accurately investigating its osteology. The celebrated Sœmmering contended, that it was one of the mammalia, resembling a bat, and other naturalists held the same opinion. But Cuvier has most satisfactorily shown, chiefly from its jaws and vertebræ, its shoulderblade and sternum, that it is between a bird and a reptile, a flying reptile. The tail is extremely short, and this indicates the animal to have used its wings chiefly for locomotion: indeed, from its very long neck, it must have had great difficulty in either walking or crawling. When at rest, it must have stood like a bird on its hind legs, and also, like some birds, have bent back its long neck in order to support its very large and heavy head. Another species of the same genus, having a much shorter beak, (for that of the former is longer than the whole body,) has also been found near the same spot. It is much smaller. Very scanty remains of a third species also occur, found in the same quarries. Its size must have been nearly four times greater than that of the kind first mentioned, and it must have presented one of the most monstrous appearances which can be conceived, according to our present experience of animal nature.

The two last discoveries among the animals of a former world, which these Researches have disclosed, remain to be mentioned; and they are, in the eyes of the naturalist, the most wonderful of the whole, although to an unlettered observer, they may appear less strange than the tribe we have just been surveying. One of them has the muzzle of a dolphin, the teeth of a crocodile, the head and breast of a lizard, the fins or paddles of a whale, but four instead of two, and the back or vertebræ of a fish. This has been named the *Ichthyosaurus*. The other, being apparently nearer to the lizard, has been called the *Plesiosaurus*;* and has also four paddles, like those of a whale; the head of a lizard, and a long neck like that of a serpent. Both are found in the older secondary strata of the globe; in the limestone marl or grayish lias, filled with pyrites and ammonites, and in the oolite beds of the formation called Jurassic. They are both chiefly found in England, and were first discovered there.

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*Πλησιος, near.

Sir E. Home, in 1814, made the first step in the discovery of the Ichthyosaurus; having obtained some bones found on the Dorsetshire coast, thirty or forty feet above the level of the sea. He gradually obtained more of these remains, until 1819–20, when the discovery was completed. But he seems to have been unfixed and variable in his opinion respecting the animal; and after believing for some time that it was partly a fish, he ended by believing it to be no such thing, and changed its name from ichthyosaurus, which Mr. König had given it, as early as 1814, to *Proteosaurus*, supposing it to have some affinity with the proteus as well as the lizard.

The ichthyosaurus is most abundant in the lias strata in the lower region of the Jura formation. Its remains are not confined to Dorsetshire; they are found in Oxfordshire, Somersetshire, Warwickshire, and Yorkshire. But at Lyme they abound, as much as those of the palæotherium do in the pits of Montmartre at Paris. Some few specimens are found near Honfleur and at Altorf; in Wirtemberg, also, a nearly complete skeleton has been discovered. Four* distinct species were ascertained by Cuvier, chiefly differing from one another by their teeth, that is to say, as far as their osteology goes.† In the general feature of their bones, they all approximate to one another. The head resembles that of the lizard, although with material differences, and even having some other bones. The eyes are extremely large, differing in this from all the greater animals both sea and land. The cavity in some specimens is above a foot in diameter. Each eye is protected by a shield of bone, composed of several pieces knitted together. The vertebræ are very numerous. In some specimens as many as ninety-five are to be seen; and these differ entirely from the vertebral system of the lizard, resembling rather that of fishes, for they are flat like backgammon, and concave on both sides. The animal has four fins, or paddles, each composed of six rows of small bones, nearly one hundred in all, and so fitting into one another, that he could paddle about by means of them, moving with more elasticity than if the bones had formed a single piece. The teeth are sharp. This creature could only breathe the air, and so must often have come up to the surface. Yet, again, he could only move in the water, and was still less able to crawl on land than even the seacalf. The length, in some cases, reaches to twenty-four or twenty-five feet. In the strata where these bones are found, there are many of the cornu ammonis and other marine shells, and remains of crocodiles exist in the same strata.

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* Four species have since been added to these.

† It cannot be too steadily kept in mind, that when a specific difference has once been ascertained, so as to distinguish one of these extinct races from another, the amount of that difference is no measure at all of the diversity, which may have existed between the two animals. Tribes the most unlike have general resemblances in the bones, the substratum on which the muscular parts are placed. Witness the ease with which unlearned persons, nay, even naturalists carelessly observing, have taken the skeletons of lizards for those of men.

The plesiosaurus was first observed in 1821, by Mr. Conybeare and Mr. Delabeche ; and in Cuvier's time, its remains had only been found in England, unless those discovered at Honfleur belong to this genus. The discovery was fully made in 1824. The distinguishing feature, the long neck, has many more vertebræ than even a swan's. In the fine specimen from Lyme, there are in all eighty-seven vertebræ, of which thirty-five belong to the neck and twenty-five to the tail. The vertebræ, though their axis is very short, resemble the crocodile's more than the lizard's. The teeth are pointed and slender. The paddles consist of many bones, in rows like those of the ichthyosaurus ; but they taper more, consist of fewer pieces, not above fifty, and are longer than those of the ichthyosaurus, nor do they form a kind of pavement like his. Five species* of this animal were distinguished by Cuvier. That found at Lyme appears to have been seven or eight feet long ; but other species, from one jawbone which has been discovered, must have reached the length of twenty-eight feet.

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* *Three have since been added.*

The eighth and last part of these Researches which we have just surveyed, is remarkable, as regards the skill and diligence of the illustrious author, for two particulars. *First*, the extraordinary success of his indefatigable investigation from very scanty materials, deserves especial attention. In some cases, he had only one or two bones to examine and to reason from. In others he had a far greater number; sometimes he had the whole skeleton in scattered parts; in a few instances, the whole together in their natural juxtaposition and connexion. But he found where he had many bones, that from a single one, or from two, he could have reached the very same conclusions which the examination of the whole led him to. This was observable in a very remarkable manner when he investigated the mosasaurus, or saurus found at Maestricht. He had not examined more than the jaw-bone and the teeth when he knew the whole animal; but he says that a single tooth discovered it to him: he had got the key; after that, every other part fell in at once of itself into its proper place. *Secondly*, Although he was not the discoverer of either the ichthyosaurus or plesiosaurus, and had to tread on ground which his eminent and able predecessors had gone over, his researches even here were quite original. He collected all the evidence, whether by drawings, descriptions, or models, of what had been before them; but he also enlarged his collection of facts by numberless specimens, both of the same kind which they had examined and of different kinds never submitted to their view. He investigated the whole as if the field had been still untrodden and the soil yet virgin; and accordingly his work, even in this subordinate branch, is far from being a repetition; his inquiries far from being a mere reiteration of theirs. Where he does not vary or extend the results at which they had arrived, he carefully confirms their propositions, and ascertains the truth of their learned conjectures; so that he adds to the precious monuments of his predecessors, by either enlarging the superstructure or strengthening the foundation.

That such a guide to our inquiries is worthy of all confidence, no one can doubt. That even his authority, the weight of his opinion, is very great, would be a proposition as indisputably true, if in matters of science it were lawful for the learned to pay any deference to mere authority; yet even here ignorant men may bow to him, and receive his doctrine with a respect which they might be justified in withholding from others. But his system makes no such appeal, and requires not to be received upon terms like these. He has given us, without any reserve, every particular which his whole researches presented to his own view; and preferring the risk of being tediously minute to the chance of leaving any point unexplained, or any position without its needful proof, there is not a fragment of bone which he has ever examined, and on which he raises any portion of his philosophy, that he has not both described with the fulness of anatomical demonstration, and offered to the eye of his reader in the transcript of accurate and luminous engraving. His work is accompanied with between forty and fifty maps and sections of strata, above two hundred and fifty plates, representing upwards of three thousand eight hundred skeletons, bones, teeth, and fragments. These are all presented to the examination of the expert, in their connexion with the author's description both of what the diagrams can, and of what they cannot, fully represent. But they are also presented to the uninformed, who can, by attentively considering them, institute a comparison between the structure of known and living animals, and those of which the earth's strata contain only the remains. Giving Cuvier only credit for having correctly written down what he observed, and accurately represented in his figures the subjects of his examination, we are enabled to see the whole ground of his reasoning; we can mark the points in which a fossil animal resembles a living one, and those in which the two differ; and we have even a higher degree of evidence in behalf of the author's conclusions, than we have in reading Sir Isaac Newton's experiments upon light, because every thing in this case depends upon configuration, which a drawing can accurately represent, whereas much in the optical case must needs turn upon appearances observed by the experimenter, and which no drawing can convey to our apprehension.

If again we compare the certainty and fulness of the proof in this case, with that which we have in examining any anatomical proposition, or any doctrine of natural history, whether of animals or of plants, we shall still find it of a separate and higher kind. For in those branches of science much more is necessarily left to description. The question here is always one purely osteological as regards the animals; and osteology is of all branches of anatomy, whether human or comparative, the one where most depends upon mere figure, and where of consequence the reader can approach most nearly to the observer in weighing the proofs on which his demonstration rests. The geological matter bears but a small proportion to the zoological in these inquiries. It is indeed of the highest importance; but it is incapable of much doubt, and admits of no mistake or imposition—for the strata where the different animal remains have been found are well known, and, in the very great majority of cases, are of easy access to all. The sciences of geology and mineralogy are sufficiently certain, at least for the main purposes of the inquiry; the names and description of the beds of the globe's surface are the portions of those sciences upon which no doubt or difficulty can exist; and the great body of Cuvier's results, remains unaffected by any differences of opinion upon speculative geology.

Thus the comparison stands, as to the degree in which the evidence is made plain to the reader of Cuvier's researches, and the reader of other records of discovery in the inductive sciences. But let us extend our view a little further, and compare the proofs before us in these volumes with those reasonings upon which the assent of mankind has been given, and is continued unhesitatingly, to the great truths of the mixed mathematical sciences. The reader of the *Principia*, if he be a tolerably good mathematician,* can follow the whole chain of demonstration, by which the universality of gravitation is deduced from the fact, that it is a power acting inversely as the square of the distance to the centre of attraction. Satisfying himself of the laws which regulate the motion of bodies in trajectories around given centres, he can convince himself of the sublime truths unfolded in that immortal work, and must yield his assent to this position, that the moon is deflected from the tangent of her orbit round the earth, by the same force by which the satellites of Jupiter are deflected from the tangent of theirs, the very same force which makes a stone unsupported fall to the ground. The reader of the *Mécanique Céleste*, if he be a still more learned mathematician, and versed in the modern improvements of the calculus which Newton discovered, can follow the chain of demonstration by which the wonderful provision made for the stability of the universe is deduced from the fact, that the direction of all the planetary motions is the same, the eccentricity of their orbits small, and the angle formed by the plane of their ecliptic acute. Satisfying himself of the laws which regulate the mutual actions of those bodies, he can convince himself of a truth yet more sublime than Newton's discovery, though flowing from it; and must yield his assent to the marvellous position, that all the irregularities occasioned in the system of the universe, by the mutual attraction of its members, are periodical, and subject to an eternal law which prevents them from ever exceeding a stated amount, and secures through all time the balanced structure of a universe composed of bodies, whose mighty bulk and prodigious swiftness of motion, mock the utmost efforts of the human imagination. All these truths are to the skilful mathematician as thoroughly known, and their evidence is as clear as the simplest proposition in arithmetic is to common understandings. But how few are there, who thus know and comprehend them? Of all the millions that thoroughly believe those truths, certainly not a thousand individuals are capable of following even any

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* It is the object of my Analytical View of that work, in another volume, to make the demonstration, the proof on which the Newtonian system rests, so easy as to be followed by persons little skilled in math-

ematical science; but the remarks in the text will, it is to be feared, always remain well founded. The like may still more be said of the Analysis of Laplace's Mécanique Céleste.

considerable portion of the demonstrations upon which they rest, and probably not a hundred now living have ever gone through the whole steps of those demonstrations. How different is the case of the propositions discussed by Cuvier and his predecessors! How much more accessible are the proofs on which their doctrines repose! How vastly more easy is a thorough acquaintance with the *Recherches*, than with the *Principia* and the *Mécanique Céleste!* How much more numerous are they who have as good reason for fully believing the propositions, because as great facility of thoroughly examining the proofs, as first-rate mathematicians can have for assenting to Newton's third book, and Laplace's great theorem, or as common readers have for admitting any of the most simple truths in the easiest of the sciences!

The extraordinary truths unfolded by the *Recherches* we have had an opportunity of stating in detail. But it is necessary to revert to some of the more general conclusions, in their more immediate connexion with the great subject of these volumes.

To the geologist, as Cuvier has well observed, the vast periods of time over which the phenomena that form the subject matter of his inquiries have extended, offer the same kind of obstruction as the astronomer finds from the immense space over which his researches stretch. The distance of time is to the one as great a difficulty, as that of space is to the other, in prosecuting his researches. Yet, as the properties of light, and its relation to media artificial or natural, furnish a help to the senses of the astronomer, so the endurable nature of the principal portions that compose the framework of animal bodies, give invaluable assistance to the labors of the geologist and anatomist, supplying records which it is as physically impossible he should have in any history of past changes on the globe, as it is that the naked eye of the astronomical observer should penetrate into boundless space. The most minute bones of small animals, even their cartilaginous parts, and the most delicate shells of sea or river fishes, are found in perfect preservation. These shells are found, too, on ground now and for ages lying high above the level of any waters, in the middle of the hardest rocks, reaching the summits of lofty mountains, lying in vast layers of a regular form and solid consistency, and which seem to demonstrate the proposition, that the sea in former ages was spread over the regions where those strata were formed, and lay there long and quietly. The level parts of the earth, which, to an observer who only regards its surface, seems always to have been in its present state, can hardly be penetrated in any place without showing, that it has undergone such revolutions, and been under the sea for ages; while the bottom of the ocean has, at those remote periods, been dry land. But when we ascend to greater heights, we find the same proofs of former changes; marine remains often show themselves on Alpine summits, but their kinds vary much from those of the lower regions; they are exposed to view by the layers in which they lie imbedded, being no longer horizontal and buried deep under ground, but nearly vertical, broken in pieces, and thrown variously about. These strata have, for the most part, been of a formation long prior to that of the horizontal ones, and were at one time displaced, and elevated and rolled about; the ocean was the great agent in their formation, as in that of the strata which it afterwards deposited horizontally around them; the ocean, too, was the agent which, after having first deposited, afterwards dislocated and raised them into rocks, promontories, and islands, amidst which the strata still found horizontal were laid.

This ocean, at different times, not only held in solution different dead matter, but was inhabited by animals of kinds that exist no more. When it last left the earth and retreated into its present position, the only one in which we have ever known it by actual observation, its inhabitants nearly resembled those which still live and swarm in its waters. But at more remote periods, and when forming its more ancient deposits, it was the receptacle of animals of which not a living trace now remains; animals all whose species are extinct; animals of genera absolutely different from any now known, and which sometimes united together, in one individual frame, parts now only found separate in distant and unconnected tribes.

Again, the intermixture of land animals and of fish, the inhabitants of fresh water only, with those of marine origin, shows that several successive irruptions of the ocean must have taken place, and that after it remained covering the land during successive periods, it retreated successively, and left that portion of the globe dry. Nor can there be any doubt that large portions of the earth, now uncovered and inhabited by the human species, and other tribes of living animals, had, before it was last covered by the sea, been dry, and been inhabited by a race of animals of which their fossil remains are *all that* we can now trace.

It is probable, too, that many of these mighty revolutions have been sudden, and not effected by gradual encroachments upon the earth, to destroy its inhabitants. The examination of masses of flesh, belonging to some of the race destroyed by the last change, and preserved by the frozen water in which they were imbedded, seems to prove that the death of the animals, and their envelopement in water, the coagulation of the water, and the introduction of a frozen climate, were simultaneous; for the putrefactive process had not commenced till thousands of years after the destruction of life, when, the ice being thawed, the exposure to heat and air began the decomposition. But the sudden violence by which these last changes were effected, is equally conspicuous in the transport of huge blocks from one part of the country to another, in which they were manifestly strangers.

But we ascend to greater heights on the surface of the globe, and we find the scene changed. We are now upon the vast and lofty chains of solid rock, which traverse the central parts of the different continents, separate the rivers that water and drain them, veil their summits in the clouds, and are capped with never-melting snows. These are the primitive mountains; formed before any of the other new-made strata whereof we have already spoken, because they penetrate them vertically; and even these primeval rocks show by their crystallization, and occasionally by their stratified forms, that they, too, were once in a liquid state, and deposited by waters which anciently held them in solution, and covered the places they now fill. In these, as we ascend to the most ancient, no animal remains at all are found. The shells and other marine productions so abundant below, and in the more recent layers of the globe, here cease altogether to exist. The primeval rocks, therefore, were first held in a liquid state, and afterwards deposited, by an ocean which contained in its bosom no living thing; an ocean which before covered, or washed, a continent, or islands, on which life never had existed.

There is also little doubt, according to Cuvier, though we give not this as an incontestable proposition, that the prodigious changes which we have been contemplating, must have been operated by a force wholly different from any that we now perceive in action, upon any portion of the globe. The power employed to work some of the displacements of which we see the traces, is shown remarkably in the insulated masses, found removed from great distances, and lying still at vast heights. On the Jura, at near four thousand feet above the level of the sea, are found blocks of granite evidently carried from the Alps, one of which, containing fifty thousand cubic feet of stone, has been removed and placed in its present position after the formation of the strata on or among which it lies,—strata, the materials of which do not fill its interstices, but have been rent and broken by its fall. None of the operations now observed on the earth's surface, satisfactorily explain either this or the other revolutions in question. The effects of weather, either in the fall of rain, or in alternate freezing or thawing of water, though sufficiently powerful, and very beneficial upon a small scale, in decomposing stones and pulverizing earths, are confined within comparatively narrow limits. The action of rivers in wearing down their banks, and changing the position of their beds, is restricted to those banks and beds, and is of slow and almost imperceptible operation, unless in some cases of rare occurrence, where a mountainous eminence, being gradually undermined, may fall and dam up a river and cause a lake to be formed, or where a lake may be let out of its reservoir, by the wearing away of some ridge forming its dam or head, and so inundate the country below; events barely possible, be it observed, and of which the period of authentic history records scarcely any instance. Then the encroachments of the sea, are even more gradual than those of rivers; nor can any proof be found, in all the time over which authentic human annals reach, of a material change in position of the ocean with respect to its shores; the utmost it has ever done being to wear away an isthmus here and there,* or cover a mile or two of low and flat coast.† The wonderful force of a column of compressed water, in a vertical fissure connected with a subterraneous sheet of it, however shallow, but filling a broad space —the resistless power of such a column to move about any superincumbent weight—has, perhaps, been too little taken into account as an agent in effecting changes on the earth's surface. But these operations must be all merely local. Volcanic action is still more topical in its sphere; and though violent enough within these narrow limits, produces consequences wholly confined to them, and unlike those which are under consideration. Lastly, whatever effect could be produced by the motion of the earth, is of incomparably a more slow and gradual kind than any now enumerated. The motion of the poles round the plane of the ecliptic, and the nutation of the axis, are movements of this kind, and never exceed certain narrow limits. The rotation of the earth has a regular and defined tendency to accumulate matter towards the equator, and flatten our globe at the two poles, but no other; and certainly neither a sudden, nor a violent effect can be operated by this means.

The result of the Researches upon the fossil bones of land animals, has demonstrated those changes still more incontestably than the examination of the remains which have been left by the inhabitants of the ocean; both because, as they must have lived on dry land, their being found in strata deposited by water, proves that water has covered parts of the continent formerly dry, and also, because their species being fewer in number and better known, we can now certainly tell whether or not the fossil animal is the same with any still living on the globe. Now, of the one hundred and fifty quadrupeds examined by Cuvier, and whose remains are found deposited in different strata of our continent, more than ninety are at present wholly unknown in any part of the world; nearly sixty of these are of genera wholly unknown, the rest being new species of existing genera; only eleven or twelve are so like the present races as to leave no doubt of their identity, or rather of their osteology being the same; while the remaining fifty, though resembling in most respects the existing tribes, as far as the skeletons are concerned, may very possibly be found, on more close survey, and on examining more specimens, to differ materially even in their bones. Nor is it at all unlikely that, of the whole one hundred and fifty, every one would be found to be of a race now extinct, if we could see their softer parts as well as their bones and their teeth. But the relation which these different species of ancient animals bear to the different strata, is still more remarkable and more instructive in every point of view.

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* There seems reason, from some ancient authorities, to believe that the Isle of Wight was once a peninsula when the tide was out, to which, tin, the staple of the ancient British exportation, was carried in wagons at low water to be shipped for Gaul.

† The estate of Earl Godwin in Kent, now covered by the sea, is one of the principal examples of this kind of change; and there must clearly be great exaggeration in the accounts given of it.

In the *first* place, it appears that oviparous quadrupeds, as crocodiles and lizards, are found in earlier strata than those containing viviparous ones, as elephants and others. The earth which they inhabited must, therefore, have existed and been watered by rivers before the chalk formation, because they are found under the chalk, in what is termed the Jurassic formation. But, *secondly*, among the strata subsequent to the chalk formation, the unknown genera of animals, palæotheria, anoplotheria, are only found in the series of beds immediately over the chalk. A very few species of known genera of viviparous quadrupeds are found with them, and also some fresh-water fishes. *Thirdly*, Certain extinct species of known genera, as elephants, rhinoceroses, are not found with those more ancient animals of extinct genera. They are chiefly found in alluvial earth, and in the most recent tertiary strata, and all that we find with these extinct species, are either unknown, or of more than doubtful identity with any now existing. Again, those remains which appear identical with the known species, are found in recent alluvial earths, and places which seem to belong to the present world. *Fourthly*, We have seen that the most ancient secondary strata contain reptiles, and no other quadrupeds. None of the rocks at all contain any human remains; nor were any remains of the monkey tribe, or any of the family of quadrumanes found in Cuvier's time, if, indeed, they are observable even now. In turf-bogs, in rents and cavities, under ruins as well as in cemeteries, human skeletons are, from time to time, found; but not a vestige of them or of any human bone in any of the regular strata, or of the fissure deposits, or of the caves and caverns which abound with all the other animal remains. Whatever human bones have been found, were undoubtedly placed there by human agency, in recent times.

For Cuvier has examined, with the utmost care, all the instances which were pretended to afford proofs of human remains. He closely investigated several thousands of the bones in the Paris basin, and in the deposits of Provence, Nice, and others. All which had ever been supposed to be human, he found to be either animal bones, or bones of men accidentally placed among the others, or in some other manner satisfactorily accounted for. The skeleton supposed by Scheutzer to be a man's, and which he made the subject of his book *Homo Diluvii Testis*, a century ago, has been already adverted to. Cuvier undertook the complete examination of it. The first skeleton which formed the subject of Scheutzer's argument was found near Amiens. Thirty years afterwards another was discovered, but its possessor, Gesner himself, raised grave suspicions that it was some lower animal's remains. A more complete one than either was after-words found. Cuvier has engraved this, together with heutzer's, copied from his own book; and how any erson could, upon the bare inspection, ever have conceived that either was a human skeleton, is truly incomprehensible. But Cuvier has further engraved a land salamander, whose osteology he had, after his admirable manner, thoroughly examined, and its likeness to the fossil remains shows it to be of the same genus, though of a wholly new species, above six times larger. He enters at large into the details of the difference between these remains and the human skeleton. But a further demonstration of their nature was reserved for him when, in 1811, at Leyden, he had access to the actual fossil itself of Scheutzer, and was permitted to remove a portion of the incrusting stone. He did this with the salamander by him, and predicted the kind of bones that would be discovered by the operation. The success of the experiment was complete; and to show the difference between this skeleton and a human subject, Cuvier had the satisfaction of also discovering a double row of small and sharp teeth, studding the fringe or border of the large circular mouth. In 1818, he had an opportunity of repeating this examination upon the last found specimen, which is now in the British Museum, and with exactly the same result. It is therefore demonstrated, as clearly as any fact in the whole compass of physical science, that these bones belong to a race wholly different from the human species, and indeed from any species now existing on the face of the globe. Finally, places where human bones have for many centuries been deposited with the remains of animals, as the ground under ancient fields of battle, have been examined, and it is found that the one are quite as well preserved as the other, and have not suffered more decay. The importance of establishing the conclusion that no human remains are to be found in the strata of the earth, will presently appear, and is the reason why we have dwelt upon the evidence in some detail.

If we next inquire, at what period the last great change took place, although of course no records can remain to fix it, yet we have some data on which to determine the limits of the question. The progress of attrition in the larger rivers, as the Dnieper and the Nile, and also the formation of downs where they approach from the sea, has been observed, as on the coast of the Atlantic in the south of France ; and the results indicate no very remote antiquity as the age of the present terraqueous distribution; certainly not more than 5,000 or 6,000 years. Of these, history only goes back about 3,000. Homer lived but 2,800 years ago. Genesis cannot have been written earlier than 3,300 years back. Even the earliest Chinese monuments that are authentic, reach but 2,255 years. The astronomical remains of the East, when closely examined, especially the Zodiac, prove nothing of that extreme antiquity which was at one time ascribed to them. Nor do the mines, such as those of Elba, from which similar inferences were formerly deduced, show, since their most accurate examination, any thing of the kind. Indeed, none of the conclusions they lead to can be regarded as at all of a certain kind. The general result of the Inquiry, then, is, that at a period not more remote than 5,000 or 6,000 years ago, a mighty convulsion covered with the ocean all those parts of the globe then inhabited by man and the other animals his contemporaries, and left dry those other portions of the earth which we inhabit. The few remains of the races then destroyed have served to people this new world ; it is only since this period began, that we have entered upon the progressive state of improvement in which our race has advanced; and to this period, whatever historical monuments we possess, of the globe or its inhabitants, are confined. But it is equally clear, that this inhabited earth, then left dry for the last time, had previously undergone several revolutions, and had been alternately dry land and covered with the ocean, more than once, or even twice, before this last revolution. We have access more particularly to examine the condition and population of the earth when it was last inhabited, that is, when the sea left it the last time but one. We are now living in the fourth era or succession of inhabitants upon this earth. The first was that of reptiles; the second that of palæotheria ; the third of mammoths and megatheria; and it is only in this present or fourth era in succession, that we find our own species and the animals which have always been our companions.

We are entitled then to affirm that, with respect to animal life, three propositions are proved, all of great curiosity, and still more, when taken either separately or together, all leading to conclusions of the highest importance.

First, That there were no animals of any kind in the ocean which deposited the primary strata, nor any on the continent which that ocean had left dry upon its retreat;

Secondly, That the present race of animals did not exist in the earlier successive stages and revolutions through which the globe has passed;

Thirdly, That our own species did not exist in those earlier stages either.

Now the conclusion to which these propositions leads, and which indeed follows from any one of them taken singly, but still more remarkably from the whole, and most especially from the last, is, that a creative power must have interposed to alter the order of things in those early times. That an interposition of this kind took place, the last and most important, about 6,000 years ago, is highly probable from the physical and natural evidence alone which is before us, and to which alone, in this work, reference can be made. But the date is not material. If, at an uncertain period before the present condition of the earth and of its inhabitants, there were neither men nor the present race of creatures, wild and domestic, which people the globe, then it follows, that between that period, whensoever it was, and the earliest to which the history of the world reaches back, an interposition of power took place to create those animals, and man among the rest. The atheistical argument, that the present state of things may have lasted for ever, is therefore now at an end. It can no longer be affirmed that all the living tribes have gone on from eternity continuing their species; and that while one generation of these passed away, and another came up, in endless and uninterrupted succession, the earth abided for ever. An interruption and a beginning of that succession has been proved. The earth has been shown not to have for ever abode in its present state; and its inhabitants are demonstrated, by the incontrovertible evidence of facts, to have at one time had no existence. Skepticism therefore can now only be allowed as to the time and manner of the creative interposition; and on these the facts shed no light whatever. But that an act of creation was performed at one precise time, is demonstrated as clearly as any proposition in natural philosophy, and demonstrated by the same evidence, the induction of facts, upon which all the other branches of natural philosophy rest.

It is wholly in vain to argue, that the sea or the earth, or the animals formerly existing and now extinct, or any other created beings, or any of the powers of Nature, as we know it, or as it has ever been known, could have made the change. It is difficult enough to conceive, how these known forces could ever have destroyed the earth's former inhabitants. But suppose the approach of some comet or other body, at different times, produced the vast tides by which the land was successively swept, this will not account for new species and new genera of living creatures having sprung up, both to inhabit the land and to people the waters. An act of creation—that which would now be admitted as a direct interposition of a superior intelligence and power—must have taken place. This is the sublime conclusion to which these Researches lead, conducted according to the most rigorous rules of inductive philosophy, precluding all possibility of cavil, accessible to every one who will give himself the trouble of examining the steps of the reasoning upon which they repose, and removing doubt from the mind in proportion as their apprehension removes ignorance. It is an invaluable addition to the science of Natural Theology, and forms a chapter as new in kind as any of the new animal species are in Natural History.

Such are the benefits conferred upon the great and fundamental argument of Divine intelligence and contrivance, by the recent discoveries in Fossil Osteology. The evidence of design, in the combination and mutual adaptation of the parts of extinct animals, we pass over, as only a multiplication of proofs sufficiently numerous before. But the other branch of Natural Theology, that which investigates the Divine Benevolence, also derives aid from this new quarter. We now refer to the argument maintained in the Dissertation upon the Origin of Evil.

The doctrine respecting the Chain of Being, is admitted to be incomplete as regards the matter of fact, inasmuch as we find many and large blanks in the series of animated creatures known upon our globe. Whatever other objections, therefore, were competent against this theory, an additional one was, that little appearance of a Chain of Being seems discernible in the universe. Now, the supporters of this doctrine have certainly a right to maintain, that the blanks are filled up in a very remarkable manner by the recent discoveries. For the new species of animals, discovered to have existed in former states of the globe, unquestionably fill up some of the most remarkable chasms in our series of living animals. Thus the chief blank was always observed in the pachydermatous animals, the fewest in number, the least approaching one another, and the whole tribe the most removed from others. Now most of the new and extinct kinds of quadrupeds belong to this class, and we have had occasion to observe how links are supplied, between race and race, hitherto appearing altogether distinct.

But although we may not be justified in reposing great confidence in the argument drawn from the plan of a Chain of Being, as applied to the subject of positive evil, there is another point of view in which the subject may, with perfect safety, be considered. As far as regards mere defect, mere imperfection, it is most important to consider whether the plan of Divine Providence may not have been to create a succession of beings, rising one above another in attributes; say, merely of intelligent beings, thus differing in their approaches to perfection. The importance of this consideration cannot fail to strike the observer, when he reflects that there is no possibility of separating one of the greatest of all positive evils, death itself, from mere defect or imperfection, as was observed in the

Dissertation already referred to; not to mention many other kinds of evils arising from mere imperfection,—as all that proceed from weakness, from ignorance, from defect of mental energy, as well as mental perspicacity. All these evils, and all their various consequences, originate in mere defect or imperfection. Therefore it is of no little moment, in this important argument, that we should be able to derive any new light to guide our steps upon that part of the ground which belongs to defect or imperfection.

Now the late discoveries certainly afford us some such lights. They show, as plainly as the evidence of facts can show any thing, that there was a time when this globe existed with animals to people it, but without any beings at all of the human kind. The sounder opinion certainly is, that there have been a succession of stages through which the earth has passed, with different races of animals belonging to each period; that in the earliest age of all, no animal life existed; that this was succeeded by another in which reptiles were found to flourish, and that subsequent periods were marked by other successive races of animated beings. But as this is the subject of controversy, we shall only say, that there have been two eras, one in which inferior animals only existed without man, and the other in which we now live, and in which our species are the principal inhabitants of the globe. This is admitted by all who have considered the evidence; and they who the most strenuously deny the other doctrines of Fossil Osteology, avow their implicit belief in the great proposition, that the relics of an age are clearly discovered in which man had no existence.

Now this position is most important with a view to our present argument. It appears that there was a time, when the Creator had not brought into existence any being above the rank of the lower animals. It follows, that the Divine wisdom had not then thought fit to create any animal endowed with the intelligence and capacity, and other mental qualities of the human species. If an observer had been placed in that world, and been called upon to reason regarding it, what would have been his reflections on the imperfections of animated Nature? Yet, after a lapse of some ages, those defects are all supplied, and a more accomplished animal is called into existence. The faculties of that animal, and his destinies, his endowments and his deficiencies, his enjoyments and his sufferings, are now the subjects of the observer's contemplation and of his reasoning. What ground has he now for affirming, that a more perfect creature may not hereafter be brought into existence—a creature more highly endowed, and suffering far less from the evils of imperfection, under which our race now suffers so much? No one can tell but that, as many of the former inhabitants of the globe are now extinct—tribes which existed before the human race was created—so this human race itself may hereafter be, like them, only known by its fossil remains; and other tribes found upon other continents, tribes as far excelling ours in power and in wisdom, as we excel the mastodon and the megatherium of the ancient world.

It is to be further observed, that no uncreated being can, by the nature of the thing, have any right to complain of not being brought into existence earlier. The human race cannot complain of having come so late into the world; nor can any of the tribes created before us complain, that they were less perfect than a species, the human, which did not then exist. Have *we*, then, the inhabitants of the present world, any better reason to complain that the new, as yet unknown, possible creatures of a future period of the universe, have not as yet come into existence? It must be confessed that the extraordinary fact, now made clearly and indisputably* known to us, of a world having existed in which there were abundance of inferior creatures, and none of our own race, gives us every ground for believing it possible, that Divine Providence may hereafter supply our place on the globe with another race of beings, as far superior to ourselves as we are to them which have gone before us. But how inconceivably does this consideration strengthen and extend the supposition broached in the Dissertation upon Evil! How strikingly does it prescribe to us a wise and wholesome distrust of the conclusions, towards which human impatience is so prone to rush in the darkness of human ignorance! How loudly does it call upon us to follow the old homely maxim, "When you are in the dark, and feel uncertain which way to move, stand still!" How forcibly does it teach us that much—nay, that all which now we see as in a glass darkly, and therefore in distorted form and of discolored hue, may, when viewed in the broad and clear light of day, fall into full proportion and shine in harmonious tints!

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* The kind of controversy which may be raised, but never has been raised on this point, I have discussed in another volume.

LABORS OF CUVIER'S SUCCESSORS.

Many learned men were attracted by the discoveries of Cuvier, and devoted themselves to the cultivation of the same science. During the last twelve or fifteen years of his life, they had joined in similar pursuits; and many of his opinions were modified, and many of his researches were materially aided, by their diligent and successful inquiries. As far as regards the general connexion between Organic Remains and Geology, indeed, another inquirer had appeared in the field as early as himself, the laborious, modest, and sagacious William Smith, a civil engineer, who, unassisted and almost unknown, had been prosecuting his researches into the mineral state of England, and performed certainly the most extraordinary work that any single and private individual ever accomplished—the delineation of the strata of the whole country, in a set of underground maps, which he published in 1815, and followed afterwards with a work upon the relation between these strata and their Organic Remains. Although the results of his investigations were published thus late, he had many years before communicated the greater part of them freely to his private friends. It must be confessed that few men of greater merit, or more unassuming, have ever adorned any walk of science, and few have ever made a more important step in assisting the progress of discovery.

The other able persons who have cultivated this branch of science are certainly endowed with greater learning, that is, book learning, than Mr. Smith could boast of, besides attending closely to actual observation in the field. Some of them, too, may fairly claim a high place as men of profound and original views. Where so many excel, and prefer claims so undeniable to the gratitude of the world, it is invidious as well as difficult to make a selection, the rather as, happily, we still have the great benefit of their continued assistance. In Italy, Brocchi; in Switzerland, Studer, Hugi, Charpentier, and Agassiz, the able and zealous disciple to whom Cuvier gave up the department of fossil ichthyology, when composing his work on Comparative Anatomy; in Germany, Von Buch, Kaup, Count Münster, Goldfuss, Rosenmuller, Wagner, and the justly celebrated Humboldt; in Russia, Fischer; in Belgium, Burtin, Omalius, Dumont; in France, Beaumont, Brongnart, Blainville, Prevost, Bouè, Brochant, Geoffroy; and in England, Conybeare, Mantell, Lyell, as incident to his Geological Treatise, Clift, Delabeche, König, Hibbert, Broderip, Fitton, Bakewell, Greenough, Owen, Murchison, Professor Sedgewick, and Dr. Buckland. These, it is believed, are all, except Brocchi, fortunately still alive, and actively engaged in the same interesting inquiries, though some of them rather confined their study to the geological portion of the subject. If from the brilliant assemblage, the names of Sedgewick and Buckland were selected, but, as regarding Fossil Osteology, the latter especially, private friendship could hardly be charged with officiously assuming to be the organ of the general voice—but, indeed, to record such merit might well seem presumptuous, where the panegyric is far less likely to reach after-times than the subject of its praise.

The labors of Cuvier's successors, as far as regards his doctrines, belong to one or other of three classes; to the progress which they have made in examining the fossil remains of former worlds, or conditions of our globe;*

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* The notes to the Analysis of Cuvier contain statements of the numbers of new species discovered since his time.

to the arguments which they have advanced in opposition to, or in support of his theory, respecting the relation that subsists between those animal remains and the strata in which they are found ; and to the arguments adduced for or against his opinions, respecting the formation and age of those strata. It may be proper to mention the things done under each of these heads, although the last is of comparatively little importance to the purpose of the present work, and the second is of considerably less moment, as regards Cuvier's proper subject, than the first.

I. Among the distinct mammalia of the pachydermatous order, we mentioned one which Cuvier referred to the tapir genus, but pronounced to have been of a gigantic size. He only had seen the jaw-teeth of the animal. But since his time other important parts have been found, chiefly at Epplesheim, in Hesse Darmstadt ; and a genus *Dinotherium* (having four species) has been established, of which this species is termed *giganteum*, his length having been apparently not less than eighteen or nineteen feet. His distinguishing peculiarity is the having two enormous tusks, which are bent downwards like those of the walrus, but are placed at the front end of the lower jaw, so as to bend below the chin. Dr. Buckland has shown by most cogent arguments, that he must have lived chiefly in the water, and these tusks in all probability were used in supporting him, anchored as it were, to the side of the river or lake while his huge body floated, as well as employed in digging for the roots upon which his teeth showed that he fed.

Notwithstanding somewhat scanty materials, Cuvier had described and, as it were, restored the megatherium with extraordinary skill. But a further importation of bones from South America has enabled observers in this country to throw some additional light upon the structure and habits of this singular animal. These bones were found in the bed of the river Salados, in Buenos Ayres, a succession of very dry seasons having brought the water unusually low. Mr. Clift, of the Surgeon's Museum, a most learned and skilful comparative anatomist, and pupil and assistant of John Hunter, examined them fully, and found many very singular particulars not before known respecting this animal. Among other things, it appears to have a bony partition between its nostrils (septum narium) like the rhinoceros tichorhinus. The structure of its teeth indicates, that they are formed by perpetual growth like the elephant's tusks, and not like his teeth by renewal. The enormous size of the tail never could have been conjectured from the analogy of the elephant and other pachydermatous animals. It was composed of vertebræ, of which the one at the root had a diameter of seven inches, and the diameter from the extremities of the processes was no less than twenty-one inches. If then allowance be made for the muscle and integuments, it could not have been less than two feet in diameter at the root, and six feet in girth. There can be little doubt that it was used both as a weapon of defence and to support the animal, in conjunction with part of his large feet, while the others were employed in digging or scraping away the earth, in quest of his food. The fore feet were a yard long, and the bones of the fore legs were so constructed, that the limb could have a lateral or rotatory horizontal movement, for the purpose of shovelling away the soil. The bone of the heel is also of extraordinary length. The proportion of his bones to those of the elephant is very remarkable. The first caudal vertebra in the megatherium being twenty or twenty-one inches; in the elephant it is barely seven. The circumference of the thigh in the former is two feet two inches, in the latter one foot. The expanse of the os illii in the former no less than five feet one inch, in the latter three feet eight inches. The bony cover of the hide has also been now more fully examined. It was about an inch in thickness, and so hard as to resist all external violence. The cumbrous movements of this unwieldy creature exposing it to many kinds of danger, the hide served to defend it from some enemies, and the weight and strength of its limbs and tail enabled it to destroy others; escape from any by flight being quite impossible. Mr. Clift informs me, that he has found in the region of the pelvis, small lumps of adipocire. So that we have here an additional instance of the softer parts of an extinct animal, still preserved in a state to which flesh is now often reduced by decomposition in water.

Mr. Darwin (grandson of the celebrated physician and poet) has found in South America many interesting remains. Among these are the bones of an edentate, between the megatherium and armadillo, (largest kind ;) those of a huge rodent, in size equal to the hippopotamus ; and those of an ungulate quadruped the size of a camel, and forming the link between that class and the pachydermata.

In the lias stratum of Lyme Regis, there was found in 1828, by Miss Anning, (to whose skill in drawing, as well as her geological knowledge, Cuvier often acknowledges his obligations,) a new species of pterodactylus with very long claws, and hence Dr. Buckland gave it the name of *Pter. Macronyx.* It appears to have been the size of a raven.

In 1824, Mr. Mantell discovered in the Tilgate sandstone, in Sussex, the remains of an herbivorous reptile allied to the iguana genus, but vastly larger ; and he gave it the name of *Iguanodon.*[*] Other parts of the animal have since been found in different places, as in Purbeck, and in the Isle of Wight. Mr. Murchison found a thigh-bone three feet seven inches long ; and in 1829, a metacarpal bone, of six inches long by five wide, was found in the iron sand, and a vertebra as large as an elephant's. The opinion of Cuvier referred the large thigh-bone clearly to Mr. Mantell's reptile, whose dimensions must therefore have been enormous, though it was not carnivorous.

In 1834, a large proportion of the skeleton was found in the Rag quarries, near Maidstone. This confirmed all the previous conjectures as to the bones separately discovered. The length of this monstrous reptile is calculated to have been seventy feet from the snout to the tip of the tail, the tail to have been fifty two feet long, and the body fourteen feet round.[†] Mr. Mantell also discovered, in 1832, in Tilgate Forest, the remains of a lizard, which may have been twenty-five feet long, and was distinguished by a set of long, pointed, flat bones on its back, some rising from it as high as seventeen inches in length. He called it *Hylæosaurus*, from being found in the Weald.

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[*] This discovery had been made before the last edition of Cuvier's book, and is mentioned, though shortly, in the Analysis.

[†] Geol. Trans. N. S. vol. iii. pt. 2.

There were found, in 1836, a great collection of fossil bones in the department of Gers, in France, in a tertiary fresh-water formation. Above thirty species, all mammalia, were traced, and of these the greater part were new extinct animals, but all were of extinct kinds ; two species of the dinotherium ; five of the mastodon ; a new animal allied to the rhinoceros, and another to the anthracotherium ; a new edentate ; and a new genus between the dog and racoon ; but the most singular and new of the whole is the under jaw of an ape, which appears to have been thirty inches in height. But we must be very cautious in giving our assent to this, until we are better informed of the position where the jaw was found. It is certainly possible ; but after the history of the Guadaloupe skeleton, clearly human, as clearly found among fossil remains, but now universally admitted to have been a recent deposit, we may pause before concluding that a deposit contrary to all other observations of fossil bones, should have occurred in any tertiary formation.*

In the time of Cuvier, at least before the completion of his great work, our knowledge was so scanty of the fossil osteology of the East, that we doubt if any allusion to it is ever made by him. Three most important contributions to this branch of science have since extended our knowledge in that direction, and a rich addition may soon be expected from Mr. Clift's labors upon a large recent arrival.

The first was by my excellent friend, Mr. Craufurd, who, travelling in the Birman empire, was fortunate enough to discover a great number of fossil remains near the river Irawadi. These he generously gave to the Geological Society, and Mr. Clift proceeded to examine them with his wonted assiduity and skill. Among them were traced two new species of mastodon, in addition to the M. gigas, and M. angustidens, of Cuvier. One is termed by Mr. Clift *Latidens*, from the breadth of his jaw teeth; and the bones of his face exceed in size those of the largest Indian elephant. The other he calls *M. Elephantoides*, because his teeth approach much nearer the elephant's than those of Cuvier's species, or of the Latidens. This animal appears to have been smaller than the elephant. A hippopotamus smaller than the living animal, a rhinoceros, a tapir, and others, have also been traced among these remains, as have a new lizard near the garial, and a crocodile near the common animal.*

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* I have lately seen an appearance of a stratum of calcareous matter, which a cursory observer would certainly have supposed to be a natural deposit in the ground ; but its history was known from some rubbish through which lime had filtered, when part of Buckingham House was built, and there were bricks, tiles, &c. underneath it.

The second of these discoveries was made on the north-east border of Bengal, at Carivari, near the Brahma-pootra river. The remains were examined by Mr. Pentland. He traced a new species of anthracotherium, which he calls *Silisestre*, a new carnivorous animal of the weasel tribe, and a pachydermatous animal much smaller than any hitherto known, either living or fossil.†

The third and most remarkable of these collections is one discovered in the Markanda valley, and the Sivalik branch of the Himmaleh mountains, in the year 1835. The curiosity of naturalists in India was immediately roused, and their industry directed towards the subject with that ardor which the relaxation of a sultry climate never abates, and that combined perseverance and ability which has ever marked the great men of our eastern settlements. Dr. Falconer and Captain Cautley have chiefly signalized themselves in this worthy pursuit; valuable aid has likewise been rendered by Lieutenant Durand; and the result of their labors occupies one half of the Asiatic Researches for 1836. They found first of all a new animal, of the ruminating class, whose scull is the size of a large elephant's, and which has two horns rising in a peculiar manner from between the orbits, with an orifice of great breadth and an extraordinary rising of the bones of

* Geol. Trans. N. S. vol. ii. pt. 3.

† Ib.

the nose. They gave it the name of *Sivatherium*, from the place of its discovery, dedicated to the deity Siva. The breadth of the scull is twenty-two inches. Dr. Buckland has no doubt that it must have had a trunk, something intermediate between the elephant's and tapir's. They next found a hippopotamus of a new species, distinguished by having six incisive teeth, and a scull materially different from the other species, whether living or extinct. A new species of tiger was also discovered, which they called *Felis Cristata*, distinguished chiefly by the great height of the occipital bone. In the same place with these bones, were found remains of the mastodon, and other known species of extinct animals ; but the most interesting discovery was that of a camel, of which the scull and jaw were found. It is to be observed, that no decisive proof of any of the Camelidæ, either camel, dromedary, or llama, had ever been hitherto found among fossil bones, although Cuvier had proved certain teeth brought from Siberia to be undoubtedly of this family, if they were really fossil, which he doubted. This discovery in India was therefore extremely interesting, as supplying a wanting genus. But for this reason it became the more necessary to authenticate the position of this supposed camel's remains the more clearly, especially as there were abundance of existing camels in the country, which there could not be in Siberia. The Indian account is somewhat deficient in this respect, leaving us in doubt whether the bones, admitted to bear a very close resemblance to the living species, were found in a stratum or loose and detached.*

Besides all these additions to our knowledge of species and genera, two remarkable observations, or sets of observations, have been first made by osteologists since the time of Cuvier. The one of these is the tracing of footsteps, the print of which has been left by animals upon the sand, or other material of the strata, while in a soft state. The other is Dr. Buckland's study of the intestines from their fossil contents, which he has called *coprolites.*[*] The first of these curious inquiries is conducted by observing the impressions which the softer and more destructible parts of animals, whose very race has been extinct for ages, made upon the earthy strata of a former world; it is the object of the other inquiry to ascertain from the petrified fæces, bearing the impress of the alimentary canal, the internal structure of extinct animals; and both subjects are certainly calculated powerfully to arrest our attention.

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* Asiatic Researches, vol. xix. pt. 1. Still more recently, it is said, a bone of the genus Junia has been found in the Sivalic Hills, and another in digging at Calcutta ; but the particulars are unknown to me.

The footsteps, it appears, were first observed by my reverend and learned friend, Dr. Duncan, (to whom the country is also so deeply indebted as the author of savings' banks,) in Dumfriesshire. On examining a sandstone quarry, where the strata lay one over the other, or rather against the other, for they had a dip of forty-five degrees, he found these prints not on one but on many successive layers of the stone; so that they must have been made at distant periods from each other, but when the strata were forming at the bottom of the sea. No bones whatever have been found in those quarries. Similar impressions, though of smaller animals, have been observed in the Forest marble beds near Bath. The marks found in Dumfriesshire, of which there were as many as twenty-four on a single slab, formed as it were a regular track with six distinct repetitions of each foot, the fore and hind feet having left different impressions, and the marks of the claws being discernible. They appear to have been made by some animal of the tortoise kind.[†] But similar marks have since been found in other parts of the world. At Hessberg, in Saxony, they have been discovered in quarries of gray and red sandstone alternating; the marks are much larger than those in Scotland, and more distinct. In one, the hind foot measures twelve inches in length, and the fore foot is always much smaller than the hind. From this circumstance, and from the distance between the two being only fourteen inches, it is conjectured that the animal was a marsupial, like the kangaroo. But one of the most remarkable circumstances observed is, that the upper stratum has convex marks answering to the concavity of the lower slab on which it rests, clearly showing that the former was deposited soft, after the latter had been first printed by the foot in a soft state and then somewhat hardened. Dr. Kaup has termed the large unknown animal *Chirotherium*,* from the supposed resemblance of the four toes and turned out thumb to a hand. In the summer of 1838, similar footsteps of the chirotherium, and of four or five small lizards and tortoises, with petrified vegetables of a reedy kind, have been observed in the new red stone at Storeton Hill quarry in Cheshire, near Liverpool. A discovery has, within the last two years, been made in the valley of the Connecticut, near Northampton, where the footsteps of various birds, differing exceedingly in size, are found in inclined strata of sandstone, and evidently made before it assumed its present position. The marks are always in pairs, and the tracks cross each other like those of ducks on the margin of a muddy pond. One is the length of fifteen or sixteen inches, and a feathery spur or appendage appears to have been attached to the heel, eight or nine inches long, for the purpose of enlarging the foot's surface, and, like a snow-shoe, prevent the animal's weight from sinking it too deep. The distance between the steps is proportioned to their length; but in every case the pace appears to have been longer than that of the existing species of birds to which they approach nearest, the ostrich. Consequently, the animal must have been taller in proportion to its size. How much larger he was than the ostrich may be gathered from this, that the large African ostrich has only a foot of ten inches long, less than two thirds of this bird, and yet stands nine feet high. These proportions would give a height of fourteen feet to the extinct animal. Some of the footsteps in the Storeton Hill quarry are eighteen inches in length. In the Forest marble of Bath, the footmarks of small marine animals are descried.

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[*] *Κοπϱος*, fæces; *λιϑος*, stone.

[†] Edin. R. S. Trans. 1828.

In examining the inside of the ichthyosaurus, the half-digested bones of the animals on which these ravenous creatures preyed are found in large masses. But there are also scattered in great abundance among their fossil remains the fæces which they voided; and these, being in a petrified state, have preserved the very form of the intestines in minute detail. The fæcal matter is generally disposed in folds, wrapt round a central axis spirally. Some of these coprolites exhibit the appearance of contortion, and show that the intestines of the animal were spirally twisted; others, especially the smaller ones, give no such indications. The scales and bones of the prey are distinctly to be traced in the mass; these are the remains, undigested, of contemporary fishes and reptiles, including smaller ones of the beast's own tribe, on which he appears to have fed, as well as on other species. The light which these coprolites throw upon the structure of the animal's intestinal canal is sufficiently remarkable. The intestines are proved to have been formed like an Archimedes' screw, so that the aliment in passing through was exposed within the smallest space to the largest surface of absorbent vessels, and thus drained of all its juices, as we find in the digestive process of living animals. The similar structure of the intestinal canal in the sharks and dogfish now existing, has been noticed by naturalists; and Dr. Paley expressly refers to it, as making compensation by its spiral passage for its being straight, and consequently short, compared with the intestinal passage in other animals. We also can distinctly trace in these coprolites the size and form of the folds of the mucous membrane that lined the intestines, and of the vessels which ran along its surface. As there is no part of the animal frame more easily destructible than the mucous membrane and its vessels, the preservation of its casts is certainly a peculiar felicity for the physiologist. Similar observations have, since Dr. Buckland's discovery, been made upon the coprolites of fossil fishes, in the Lyme Regis lias, in Sussex, in Staffordshire, and near Edinburgh. In some places they take so fine a polish, that lapidaries have used them for cutting into ornamental wares. One of the most singular coprolites was found by Lord Greenock (an assiduous and successful cultivator of natural science) between the laminæ of a block of coal near Edinburgh, and surrounded with the scales of a fish recognised by Professor Agassiz as of contemporary origin. To these observations a very curious addition has been made by the Professor, who found that the worm-like bodies described by Count Munster, in the lithographic slate of Solenhofen, are in fact the petrified intestines of fishes, and he has also found the same tortuous bodies occupying their ordinary position between the ribs, in some fossil remains. He has named them *Coleolites* ;[*] and certainly the representation given of them in the drawing, resembles an actual intestine as accurately as if it were the portrait of it.

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* *Χειρ*, hand.

When Cuvier abandoned to Professor Agassiz the whole department of Fossil Ichthyology, he showed as happy and just a discernment of living character as he ever displayed in the arrangement and appropriation of animal remains. That admirable person has amply earned the honor thus bestowed on him, by devoting his life to this extensive, obscure, and difficult study. The results of his laborious researches have been from time to time published, in a great work upon fossil fishes ; but as the arrangement followed as yet in the publication necessarily leaves the several parts incomplete, a distinct and satisfactory view of the whole, cannot be formed until the work is finished. Some of the discoveries, however, which bear upon the subject of our present inquiries may be shortly described. The importance of the study to fossil geology is manifest from this, that the class of fishes being continued through the successive periods of the different formations, while those of land animals are confined each within certain limits, and the fishes being also inhabitants of those waters in which all the aqueous deposits once were contained, we are enabled by Fossil Ichthyology, through various periods of the earth's formation, to pursue the comparison of a vertebrated animal's condition in each stage.

The Professor's classification is founded upon the form of the scales, which are adapted to the structure of each tribe, and afford a perfectly scientific principle of arrange-

[*] *Κωλον*, the great intestine.

ment. He thus divides the whole into four orders :—the *Placoideans*,[*] whose scales are irregular enamel plates, more frequently broad, but varying in dimensions down to a point or prickle ; the *Ganoideans*,[†] with angular scales of bone or horn thickly enamelled and shining ; the *Ctenoideans*,[‡] with comb-like scales having a jagged edge and no enamel ;[§] the *Cycloideans*,[||] whose scales are smooth at the edge and composed of horn and bone, but unenamelled.[¶]

There were in all eight thousand species of fish enumerated by Cuvier, of which more than three fourths, or six thousand, belong to the two last classes, and no one of either of these classes has ever been found in any formation anterior to the chalk; so that the whole of these six thousand kinds of fish have, to all appearance, been called into existence at a period long after the primitive, the transition, and all but the latest secondary formations. On the other hand, and in the earlier times of the secondary and transition strata, there existed species of the other two orders, which have comparatively few representatives surviving to our days. The Professor has thoroughly examined eight hundred fossil species of these two orders, and finds not a single exception to the rule thus laid down, for the relation between different species of animals and successive formations of strata.[**] His deductions received further corroboration by the examination of two hundred and fifty species, all of new and extinct fishes, submitted to him in England, and which were, for the most part, found in that country. The analogy in this respect, between the results of Fossil Ichthyology and those of Cuvier's Researches, is striking throughout. In the lower deposits of the lias there are found the remains of the great sauroid fishes, analogous to the fossil lizards of the same strata. More than two thirds of the fishes found in the chalk strata are of genera now extinct. These extinct genera, however, of the newest secondary strata, approach more nearly to the fishes of the tertiary strata, than the fishes found in the oolite or Jurassic formation ; insomuch that the Professor is disposed to range the chalk and greensand nearer to the tertiary than secondary formations on this account. Not a single genus even of those whose species are found in the Jurassic deposits, is now known among existing fishes ; nor is there a single species, and but few genera, common to the chalk, and the older tertiary strata. A third of those found in the strata of the later tertiary formation, as the London clay and the coarse limestone of the Paris basin, are of extinct genera. The Norfolk crag and upper sub-appenine formation have, for the most part, genera found in the tropical seas ; the tertiary formation generally approaches nearest to our living species, but the Professor affirms that, except one small fish, found in modern concretions on the coast of Greenland, not a single species exactly the same with those of our seas, is to be found in a petrified state. This continued analogy is very important in a geological view.

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[*] Πλαξ, a tablet or plate.

[†] Γανος, brilliancy.

[‡] Κτεις, a comb.

[§] Perch belong to this class.

[||] Κυκλος, a circle.

[¶] Salmon and herring are of this class.

[**] Rapport sur les Poissons Fossiles, 1835, p. 38.

In a zoological view it would be endless to attempt any analysis of the Professor's researches. Among the extinct species, no less than one hundred and fifty belonged to the family of sharks, whose services, in keeping down the increase, naturally so rapid, of fishes, have been required in all ages of the ocean. Different kinds of shark, however, appear to have belonged to different periods. Of the three sub-families into which the Professor divides the great class of sharks, the first is found in the earliest period of organic remains, the transition strata, and continues till the beginning of the tertiary, but there is now only one species of it existing, and that is found in New Holland. The second sub-family begins probably with the coal formation, and ceases when the chalk commences. The third begins with the chalk, and continues down through the tertiary formation to the present time. The form as well as the size of the extinct species differ in most things materially from the living, and in no respect do they vary more than in their covering or scales.

As the coprolites enable us to ascertain the interior structure of the extinct reptiles, so do they throw li[illegible] upon that of fishes also, those especially of the saur[illegible] or lizard-like kind. We have even instances of the[illegible] intestines being partially preserved by some fortun[illegible] accident. An example near Solenhofen has been me[illegible]tioned already. A specimen was found in Sussex, whe[illegible] the stomach, with its different membranes, was retained. In a number of fishes found in the Isle of Sheppy, th[illegible] bony capsule of the eye was found entire ; and in some[illegible] other instances, the plates forming the gills or branchi[illegible] are perceivable.

It thus appears that great and important additions hav[illegible] been made to this interesting science since Cuvier, wh[illegible] may properly be termed its founder, ceased from hi[illegible] labors. But it would not be proper to pass from a consideration of the services rendered by his successors, without making mention of one illustrious inquirer, a man of truly original genius, who preceded him by a few years. John Hunter, whose unrivalled sagacity seemed destined to cast a strong light upon whatever walk of science he trode, had turned his attention, as early as 1793, to fossil bones, in consequence of a collection sent to England by the Margrave of Anspach. He described and commented upon them in detail with his wonted acuteness; he adopted the same safe and natural course which Cuvier afterwards pursued with such signal success, of examining the known bones of existing species as well as those submitted to his consideration ; and it appears, from some of his concluding remarks, that he perceived distinctly enough the specific difference of the fossil animals, at least of some among them. Thus, having compared the fossil scull of a supposed bear with that of a white bear, which he had procured from the owner of the animal while alive, he gives an accurate drawing of both, and marks their diversities, indicating his opinion that the fossil animal differed from all known carnivorous animals.* Who does not perceive that he was on the right track, and would have reaped a plentiful harvest of discovery, he devoted himself to the general investigation of the bject ?*

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* Phil. Trans. 1794, p. 411.

II. The speculations of succeeding zoologists or comrative physiologists, have not only made no impression on the anatomical results of Cuvier's inquiries, but y never appear to have been pointed towards that obt. Considering the numberless instances in which he d to draw his conclusions, or to form his conjectures, m a very imperfect collection of facts, it is wonderful w constantly the fuller materials of his followers have nfirmed his inferences. But geological inquirers have casionally impugned his doctrines respecting the relation the classes of animals to the successive formations of e strata that incrust our globe. It has been denied by me that any such relation at all can be truly said to ist. There seems, however, no possibility of maintain this position, whether we agree wholly with Cuvier r not in the detail of his statements. For the fact is ndeniable that some strata, let them have been arranged whatever succession, formed and placed by whatever auses, contain the remains of certain classes of animals which are not to be found in other strata. It is another act equally indisputable, that no animals now exist of the ame kind with the greater part of those found in any of he strata. This appears to connect the different races f animals with the different strata. But it is said, that his is not a chronological connexion, and affords no evilence of strata having been formed rather in one age han another. If it were so, there still would remain a oundation for the position which merely affirms a relation etween organic remains and strata. But is it true? The principal reason assigned is, that although no animals f a certain kind are found in certain strata, supposing hose strata to have been formed at a given period, the nimals of the kind in question may have perished so as ot to have been washed into the sea or other water in which the earthy matter was mixed, and from which it was deposited. Now, not to mention that this bare possibility becomes improbable in the degree in which the facts are multiplied and the observations of animals and strata extended, the researches respecting fossil fishes seem to negative the objection entirely. For if the different strata were made by the sea, and contain totally different remains of marine animals, it is clear that each must have been formed respectively in a sea inhabited by different animal tribes. The strict parallelism, too, which is observed between the connexion of different races of animals and that of fishes with different strata, lends the strongest confirmation to Cuvier's doctrines.

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* In the Hunterian Museum there is a large collection of fossil organic remains, selected with consummate skill, and showing the attenion bestowed by this great man on the most delicate parts of organization which they exemplify.

Ingenious and laborious attempts have been made to show, that though many races of animals are now wholly extinct, the evidence fails to prove the nonexistence of any race (except our own) at a preceding period; in other words, to disprove the proposition, that many of the present races came for the first time into existence at a period subsequent to the time when we know that others existed, always excepting the human race, which it is admitted we have sufficient reason to believe did not exist in the earlier stages of the globe's formation. It cannot, however, be denied, *first*, that the extinction of many races of animals, which is admitted, affords a ground of itself for thinking it probable, that new ones should be found to supply their places; *secondly*, that there seems nearly as little reason to regard the utter extinction of some classes, as more improbable than the formation of others; *thirdly*, that the admitted creation of man destroys the whole support which the objection might derive from a supposed uniformity of natural causes, always acting, and removes the difficulty said to exist, of assuming different sets of principles to be in action at different periods of the world; *fourthly*, that the great number of facts which have been observed, all pointing uniformly in one direction, cannot be got over by suggesting mere possibilities for explanations. The improbability is extreme of one set of animals having existed at the same age with another set, when we find certain strata having the traces of the former without any of the latter, and *vice versâ*. This improbability increases in proportion to the number of the species. If these exceed hundreds, and even amount to many thousands, the improbability becomes so great as to reach what, in common language, we term a moral impossibility. Now, there are six thousand kinds of fishes, of which not one specimen is to be found in any of the formations preceding the chalk. But suppose we lay out of view all question of one formation being older than another, there are certain strata in which none of those species are found. There is no disposition to deny that these strata were formed in the water; therefore, at whatever time they were suspended in the water, that water at that time contained none of those six thousand kinds which now people it. Then from whence did they all come, if they existed at that period, and yet were not in the water when the strata were formed? But it is equally admitted, that the water in those days contained many other kinds of fish now extinct, and found only in certain strata, and it contained some few which we find in other strata, and some which are still to be found in the sea. Can any thing be more gratuitous than to suppose, that all the fishes of a certain class were destroyed at the formation of those strata, while all those of another class were afterwards brought from a different part of the sea to succeed the last ones, and a certain small number survived to mix with other strata, or even to last till now?

The only sound objection that can be taken to the theory, is that to which the absolute assertion of the fact is liable. We can easily ascertain that certain species are no longer to be found living on the globe. But we may not be so well able to affirm with certainty, that certain fossil genera of one formation may not hereafter be found in another, or, which is the same fact in another form, that certain living species may not be traced among fossil remains. Thus the small family of the camel was wanting in all our fossil collections, till the late discoveries in the Himmaleh mountains have made it probable, that a species of this class may be found to have existed there with the mastodon and other extinct mammalia. This is possible, perhaps likely. So an ape's jaw is supposed for the first time to have been found in a fossil bed in France with other races, and no quadrumane had ever been before traced in any part of the fossil world. The proof of this discovery is, however, as yet, involved in some doubt; and even were it more precise, we should only have two instances in which the negative evidence had failed, leaving a multitude of others, hundreds of land and thousands of sea animals, of which no representatives are to be traced among the fossil remains of any country. It must always be recollected, that the whole argument rests upon probability, more or less high. Even as regards the admitted nonexistence of the human species, the mere evidence of osteological researches is not demonstrative; for although it is quite certain, that among the thousands of animal remains which have been discovered and carefully examined, not a fragment of a human bone is to be found, it is barely possible, that in some deposits as yet unexplored, the skeleton of a man may be discovered. We have at present only to make our inference square with the facts; to affirm that, as far as our knowledge extends, there is no such relic of our race in the earlier strata of the globe; and to conclude that, considering the extent of past inquiries, the regularity of the connexion between other races of different kinds and various strata, and the portions of the earth over which our researches have been carried, the very strong presumption is against any such contradictory discovery being hereafter made.

III. Whatever opinion men may form upon the question raised by some antagonists of Cuvier's geological doctrines, all must allow, that considerable light has been thrown upon the subject of discussion by their labors. Indeed a considerable addition to our knowledge has been made by some of these able and learned men, even admitting that they have failed to impugn the theory, and taking the facts which they have ascertained as forming an addition, by no means inconsistent with it. Thus the valuable work of Mr. Lyell has, in two essential respects, greatly advanced geological knowledge. He has examined, with a much more minute attention than had ever before been given to the subject, the action of the physical agents actually at work before our eyes, and has shown how extensively these may operate upon the structure of the earth's surface. It may be admitted, perhaps, that Cuvier had somewhat underrated their power, although the reader may still retain his opinion, that the force ascribed from the facts to those ordinary physical powers is inadequate to produce the effects which the phenomena present; that all the violent and sudden actions known on the globe are topical, being confined within comparatively narrow limits, and that the supposition of sudden and even instantaneous change on a vast scale in former periods has been too lightly taken up. Indeed, unless we suppose such changes as might happen from the disruption of a continent united by a small neck of land, like that which may be found once to have joined Gibraltar and Ceuta, it seems hard to imagine how a tract of country, extending from Holland to beyond the Caspian, and from Scandinavia to the Carpathian mountains, could be drained of the sea, which certainly once covered it, or, having still more anciently been dry, could have been laid under water.*

But a much more important service has been rendered by Mr. Lyell's comparison between the different formations of the tertiary class; and although it is with unavoidable distrust of himself that any one little versed in geological science should venture to speak, it should seem that the division which he has thus succeeded in tracing of the tertiary period, may stand well with the previous system of Cuvier, and be received as a fact independent of the controverted matter with which it has been connected. With the important aid of several eminent conchologists, but especially of Mr. Deshayes, he examined the numbers of testaceous animals traced in different formations; and finding that in some strata the proportion of shells of living species was very different from others, he distributed the strata of this tertiary period into three classes accordingly; the earliest being those which contained the fewest of our living species. The latest of the three periods into which he thus subdivides the tertiary era he calls *pliocene*,[*] or more recent; the next before, *miocene*,[†] or less recent; the earliest *eocene*,[‡] or dawning. Seventeen species of shells are common to the three divisions, of which thirteen still exist and four are extinct. In the pliocene, the proportion of existing shells always exceeds one third, and usually approaches one half of the whole found. In the miocene, the existing shells fall considerably short of one half, that is, the extinct species preponderate; indeed, of one thousand and twenty-one examined, less than a fifth were existing. There are one hundred and ninety-six common to this and the last period, of which eighty-two are extinct. In the eocene period, the proportion of existing shells is much smaller, not exceeding three and a half per cent.; and there are only forty-two common to this and the miocene. In the Paris basin one thousand one hundred and twenty-two species have been found, of which only thirty-eight are now known as living.

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* In Mr. Whewell's learned work on the History of the 'Inductive Sciences,' there are some acute and important remarks on the two theories, that of Uniform Action, and that of Catastrophes. B. xviii. c. 8.

The theory of Cuvier and Brongnart, respecting the successive formations in the Paris basin, appears to require some modification in consequence of more recent examination. They considered that upon the chalk there was laid, first, a fresh-water formation of clay, lignite, and sandstone: then a marine formation of coarse limestone; and then upon that, a second fresh-water formation of silicious limestone, gypsum, and marl. The researches of Mr. Constant Prevost seem to show, that instead of these three successive formations, there were laid on the chalk a clay formation of fresh-water origin, and then upon that, contemporaneously, three others, in different parts of the same basin, namely, a fresh-water formation of silicious limestone, another of gypsum, and a marine formation of coarse limestone. In the rest of the series, the two theories coincide.

[*] *Πλειων*, more, and *καινος*, recent.

[†] *Μειων*, less.

[‡] Ηως, dawn.

It must, however, be observed that the more important doctrines of Fossil Osteology, even as regards their connexion with the history and structure of the globe, do not necessarily depend upon the opinions which may be entertained of the more controverted points of geological theory, while the science of comparative anatomy exists alone, self-contained, and independent of geology. But all must agree in admitting the important service which Osteology has rendered to geological inquiries, and in rejoicing at the influence which it has had upon those who pursue such speculations, in promoting a more careful study of facts, and recommending a wise postponement of theoretical reasoning, until the season arrives when a sufficient foundation for induction shall have been laid by the patient observer.

NOTES TO THE FOSSIL OSTEOLOGY.

NOTE I.

As some learned men are satisfied with the proofs of an ape's jaw-bone having been found at Sansan, in the southwest of France, and an astragalus of the same genus in the Sivalic hills, it is very possible that this genus may be added to those found in the strata of the Miocene period; for it is only in the more recent formations that these remains are supposed to exist. That they should be found in any of the Pliocene formations is in a high degree improbable; and even then we have only got to the middle of the Tertiary period. No one contends that, in the earlier formations, any such remains are to be traced.

But in case any objection should be raised to the argument in the text, upon the supposition that, because quadrumanous animals were supposed by Cuvier not to be traceable in any but the present portions of the globe's crust, therefore human remains may likewise hereafter be found in earlier formations, we may remark that, even if they were, contrary to every probability, there found, no one pretends to expect such remains in those strata where no mammalia of any kind have been discovered; and the argument in the text is wholly independent of the particular period at which the nonexistence of our race is admitted. These considerations are fit to be borne in mind, since learned men, like Mr. Schmerling, are inclined to think that some human bones, found in the same caves with the remains of hyænas and other animals, are of contemporaneous origin. The great majority of geologists, however, refer the animals in question to the last geological *era before* the creation of man.

NOTE II.

THE state of rapid and solid advancement in which the science of Palæontology now is, may make the summary of its doctrines in any one year little applicable to the next. The notes to the Analysis of Cuvier, and the subsequent account of the labors of his successors, may serve to show what inhabitants of the former surface of the earth are at present within our knowledge. But with respect to the two important classes of ichthyosaurus and plesiosaurus, the following abstract will prove convenient to the student who would compare the present state of our information upon these two fossil genera, with what it was when Cuvier wrote. Nothing can better exhibit the rate, as it were, at which this science has been advancing. I am indebted to my learned, able, and excellent friend, Mr. Greenough, for this summary, which will be found to be marked with the accuracy, the clearness, and the conciseness which distinguish all his productions.

ICHTHYOSAURUS.

1. **Communis**....Cuvier, vol. ii. Lias—England and Wirtemberg.
2. **Coniformis** ...(See Journal of Acad. of Philadelphia.) Not known to Cuvier. Lias—Bath.
3. **Grandipes**....(Geol. Proc., 1830.) Not known to Cuvier.
4. **Intermedius** ..Lias—England and Wirtemberg.
5. **Platyodon**.... Lias—England and Wirtemberg.
6. **Tenuirostris** ..Lias—England and Wirtemberg.
7. **Ichthyosaurus**.Kimmeridge clay.
8. **Ichthyosaurus**.Muschelkalk—Luneville and Mannsfeld.

PLESIOSAURUS.

1. **Goldfussii** ... Quarries of Solenhofen. Not known to Cuvier.
2. **Carinatus** ... Lias—England and Boulogne.
3. **Dolichodeirus** .Muschelkalk—Germany ; and lias—England.
4. **Pentagonus** .. Jura beds—France.
5. **Profundus** ... Variegated sandstone—Jura. Not known to Cuvier.
6. **Recentior** ....Kimmeridge clay.
7. **Trigonus** .... Calvados—north of France.
8. **Trigonus**.....Cuvier, vol. ii. p. 486. Lias, probably.

APPENDIX II.

[The following Dialogues (as also the preceding Analytical View of Cuvier's Researches, and several articles which have been incorporated into the text of the preceding volumes) are extracted from a work by Lord Brougham, published the present year, (1839,) and entitled, 'Dissertations on Subjects of Science, connected with Natural Theology.' Some few paragraphs, such as those relating to local matters, incidentally introduced, have been omitted, but nothing at all affecting the argument. Whether all of our readers will consider the results, to which the author arrives, as conclusive of the points discussed, as he undoubtedly does, we think very questionable. Still, considering the character of the writer, the prominent part he has long taken in diffusing knowledge among all classes, and the great indebtedness which the present and the rising generation are under to him, intellectually and morally, his opinion is worthy of a careful examination, though we may dissent from him in some of his views and propositions, especially the metaphysical ones occasionally interspersed. In his Preface, the Author observes, "The form of Dialogue appears to me eminently suited to the thorough sifting of a subject, confessedly extremely difficult, and on which, there as yet can hardly be said to exist the means of laying down satisfactory, clear, and unquestionable doctrines. The whole arguments, on all its parts, are thus subjected to scrutiny; all possible objections are brought under consideration; and the ground is cleared for future discovery, even if no results shall, for the present, be obtained, sufficiently free from doubt, to rest upon. I do not certainly conceive, that, in the present case, no progress has been made towards such results; but the doctrine is still encumbered with much difficulty; and there exists no work, to my knowledge, in which the subject has been fully investigated. In the writings of ancient philosophers, this form of inquiry was very generally adopted. But it must be admitted, that, in almost every instance, the form alone was observed. An excuse was thus given for making the discourse more desultory and less elaborate than a complete and systematic dissertation; but the prolocutors were very far from dividing the argumentation among them. One, alone, as Socrates in Plato's Dialogues, performed nearly the whole, and the others were merely assenters. In the following Dialogues, the conflict of argument, on either side, is real throughout; so that the subject is fully sifted, and the argument placed in all the lights in which it was found possible to view it."]

BOOK, OR DIALOGUE I. INSTINCT—INTRODUCTION; (FACTS.)

WHEN the General Election of 1837 was near its close, Lord A. came to me, on his way to the North, where he was minded to diversify, with field-sports, his habitual life of farming. Those pursuits had never interfered with the duty he owed his country, as long as he deemed that the sacrifice of all his domestic comforts, could prove serviceable to his public principles; nor had they ever, at any time, prevented him from cultivating a sound philosophy, in the study of which, much of his leisure is always consumed. When I passed a few days with him, at Wiseton, the summer before, we had discussed together some of the more interesting topics, which form the subject of these speculations, connected with Natural Theology, though of a substantive interest, independent of the relation in which they stand to that sublime inquiry; and, while I remained at Harrington, we had corresponded frequently, on the subject of Instinct, one of the most curious, in its minute details, and of the most interesting, in its bearings upon the philosophy of mind, independent of its immediate connexion with theological speculations, but, it must at the same time be admitted, one of the most difficult, and upon which the labors of philosophers have cast a very imperfect light. It was natural, then, that we should renew these discussions, when we afterwards met, in Westmoreland. The weather being fine, we ranged somewhat among the lake scenery, and by the rivers and through the woods which variegate our northern country; and coming to the island, in the neighboring river, found a convenient seat, where the discussion might be carried on, under the cool shade, which the wood afforded against an autumnal sun: "Here," said I, "we may resume our Wiseton conversation."

A. Have you reconsidered my opinion, or rather the inclination of opinion, which I had, last year, that it will be advisable, if not necessary, to begin with defining Instinct, in order that we may the more clearly understand what we are discussing?

B. I have, indeed; and I remain of my own, as often happens through obstinacy and unwillingness to give up a preconceived notion; but here it is, I believe, from much reflection upon the subject, that I still regard the definition as rather the end of our inquiry than its commencement. Indeed, this may generally be observed of metaphysical, or rather psychological* inquiries: they are not like those of the mathematician, who must begin by defining; but that is because his definition is, in fact, a statement of part of the hypothesis in each proposition. Thus, whoever enunciates any proposition respecting a property of the circle, predicates that property of a figure whose radii are all equal; and it is as if he began, by saying, "Let there be a curve line, such that all the straight lines drawn from its points to another point within it are equal, then I say, that the rectangles are equal, which, &c." The general definition, only saves the trouble of repeating this assumption, as part of the hypothesis in each proposition. But the nature of instinct, or of any other thing of which we discourse in psychology, is not the hypothesis we start from; it is the goal or conclusion we are seeking to arrive at. Indeed, so it is in physical science, also; we do not begin, but end, by defining the qualities of bodies, or their action on one another.

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* [From *Psychology*, a word derived from the Greek, signifying, the science of the soul. "The object of it is to teach the laws and relations of the changes and phenomena of the mind, during the intellectual operations; or to trace their causes, to discover the nature of the mind and its relations to the universe; or in short, to treat of the mind, either as it manifests itself, or as it is, in itself."—*Encyclopedia Americana.*]

A. I grant this. But, if there be more things than one, which men call by the same name; for example, of Instinct, must we not begin by ascertaining what we mean by the word, in order to avoid confusion? And this seems to bring on the necessity, at least of some definition.

B. I agree, that there must, in this case, be a definition; but it is only a definition of terms, and does not imply our stating the nature of the thing defined: it only implies, that we must understand what the thing is, to which the given word applies, and, if two things go under the same name, that we should be agreed, in the outset, which of the two things we mean, when we use the word; perhaps, that we invent some second name, or give some qualifying addition to the given one, to express one of the two things, and keep the different meanings distinct.

A. The best way will be, that we should come to particulars, give an example or two: perhaps it may suffice to mention the different kinds of Instinct, if, which I take for granted you do not doubt, there be more things than one, going under that name.

B. Certainly; and there can here be no difficulty, at all, in our way; and, to show you how little alarmed I am, at defining, when it is clear that I am only called upon to define a word, and thereby make a distinct reference to a thing known or unknown in its own nature—not to pretend giving an account of that nature—I will at once begin, by both inventing names, and defining their meaning. There are some Instincts, which may be called *physical*, and others, *mental*, in the animal system; by physical, I mean those actions or motions or states of body which are involuntary; as the action of the heart, and the peristaltic [worm-like] motion of the bowels, over which, generally speaking, we have no direct control by the operation of the will; for I put out of view such rare instances, almost monstrous, as Darwin has recorded, of a person who could suspend the pulsations of his heart, at pleasure, and another, still more rare, of one who could, at will, move his bowels, by accelerating the peristaltic action.* Even if all men could acquire such control over those motions, they would still be involuntary; because they could still be carried on, wholly without our will interfering, and without our minds necessarily having any knowledge, whatever, of them. So the secretions are all performed involuntarily, and may go on, wholly without our knowledge; we can affect them, as we can the involuntary motions of the heart and fluids, indirectly, because the passions and feelings of the mind have always an effect upon them; but still they exist and proceed, the parts perform their functions, and those functions serve the ends of their appointment, wholly independent of our will, or of any effort, whatever, on our part. We can affect them, also, immediately, through the influence of physical agents, voluntarily applied as stimulants or sedatives, or the operation of voluntary motion, as well as mediately by the power which the mind derives from its union with the body; but they can go on, of themselves, and, in all cases of healthy condition, go on better, without any the least interruption on our part, than with it.

A. This is certain: my only doubt is, whether these can be justly or correctly termed instinctive operations, at all. When I speak of Instinct, I mean something very different; namely, those voluntary movements, or that voluntary action of the mental faculties which is contradistinguished from reason. However, there is no harm, but much convenience, in beginning, by defining and classifying, so as to leave, on one side, the physical and involuntary instincts—those things which may, properly enough, be called incidents of animal life, because there seems great difficulty in drawing a line between such motions and actions, and those which subsist in vegetables.

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* Zoonomia.

B. There does, certainly, appear to be this difficulty. I hardly see how any line can be drawn, between the motions of the lowest species of animal, the mollusca for instance, and those found in plants. There is, in both, organized form, a system of vessels, growth by extension not by apposition, a circulation of fluids, and secretion of solids from those fluids, or of one fluid from another. There is also production of seed, and from the seed, continuation of the species. But it is not only convenient that we should define, in order to leave, on one side, what we are not to discuss, that it may not confound our inquiry; the definition and classification may also carry us on, some little way, in our argument with respect to the other class of Instincts—Instinct properly so called—the Mental Instincts; at least, it seems to furnish us, at the very outset, with an analogy.

A. I have a dread, at least a suspicion, of all analogies, and never more, than when on the slippery heights of an obscure subject; when we are, as it were, *inter apices* [among the heights] of a metaphysical argument, and feeling, perhaps groping, our way, in the dark or among the clouds. I then regard analogy as a dangerous light, a treacherous *ignis fatuus*, [wildfire or jack-with-the-lantern,—a deception.]

B. It is even so, if we follow it beyond where we can see quite clear, and find a firm footing. But all light is good; and the best way is, not to despair, still less put out any glimmering we have, but rather to increase it, by adding others, or make it available, by using apt instruments. However, we are getting too metaphorical; only it is my comfort, that you began, and that I am led astray by one, who, as you said in your inimitable letter to your Lancashire antagonist, is not one of "the eloquent people." But, to return from where your poetical imagery led us, analogy may sometimes illustrate, and it may often lead to useful and strict inquiry, by suggesting matters for comparison and investigation.

A. Then what comparison do you make, between the two kinds of Instinct? or rather, as the question is of analogy, how do you state a relation of the mental Instinct, which we shall call Instinct, simply, if you please, similar to, or identical with, some relation of physical Instinct?

B. As thus—the physical Instincts are independent of will, or mind, altogether, though they never are found, except where animal life, and consequently mind, exists; but yet mind may influence them. Just so, the mental Instincts are independent of reason, altogether, though they are found in union with it, and reason may influence them. It is a question, if they are ever found without reason; for that depends on our solution of the *vexata quæstio*, [disputed question,] "Whether the lower animals have reason, at all, or no?" Therefore, I will not say, that here the analogy is complete, and will not affirm, that, as physical Instinct is never found, without animal life, so mental Instinct is never found, without reason; but we may safely say, that, in this other respect, the analogy is perfect, namely, that, where mental Instinct is found with reason, it can act without reason, though reason may also interfere with it; and in this respect, at least, reason seems to bear the same relation to mental Instinct, which animal life bears to physical Instinct. We may go further, and add, that as in plants, where the motions are without animal life, those motions are more perfect and more undisturbed; so, if there be any animal, wholly without reason, the operations of mental Instinct are the more regular and perfect; and, in any animal, whatever, they are so, in proportion as reason is dormant or inactive.

A. It may be as you say; but this will not carry us, as you seem to be aware, far on our road. However, it is well enough to remark it; for we thus gain, perhaps, a clearer and more steady view of the relation between Reason and Instinct, always supposing that there is any warrant for treating the two as different: because you are aware that some have considered them as identical; I mean, not merely by denying that there is any specific difference, any difference in kind, between our faculties and those of brutes, though this denial is of course involved in their doctrine, but by going a step further, and holding, that what we call our Reason, and are so proud of, is merely a bundle of Instincts, as some have termed it—a more acute and perfect degree of Instinct. Smellie, in his entertaining work on the Philosophy of Natural History, holds this opinion. That is a book, by the way, much less esteemed than it deserves, even as a collection of facts and anecdotes; but I also think the honest printer, (for such he was,) had a good deal of the philosopher in him. I suppose, as the well-educated printers in the foreign university towns, and some of our own Oxford men, used to be critics and scholars, from the atmosphere of the place, so your Edinburgh printer, when well bred, is a metaphysician.

B. You are right, as to Smellie, at least, and I agree with you as to his book, though it is too long, and in parts loosely reasoned, as well as not over-accurate in his facts, according to what I have heard from naturalists. But he was a man of considerable merit; and lived a good deal in the literary and scientific circles of Edinburgh. I knew him, but slightly. He would have done much more, had his habits been less convivial. But I rather fancy the somewhat pretending title of his book, tended to make men disallow the merit, which it unquestionably has.

A. But what do you hold of the dogma in question, and of which he is, perhaps, the most round asserter?

B. I entirely deny it; nor do I conceive that any part of the subject is more free from all doubt, than this, unless indeed we come to the question of liberty and necessity, and resolve the whole into a mere dispute about terms.

A. Liberty and necessity! preserve us!—I am taken by surprise. Why I had no idea that we could have got among those heights and clouds, already—"Apart set on a hill retired," and reasoning on "free-will," like the gentry more acute than amiable, who held their metaphysical disputations there.

B. Don't be alarmed; but the subjects, in one single point, do certainly touch. What I mean is this; if you say that, when a man reasons, one idea suggests another, and that he must follow the train, and can no more avoid drawing his conclusion, when he compares two ideas, than a bird can avoid building its nest in a particular fashion, or a bee can help making hexagonal cells, then you seem doubtless to liken Reason with Instinct. But this is true, only on the supposition that a man's *mind* is mechanical, and that his faculties are placed beyond his control. Now, suppose it to be admitted that I cannot avoid drawing a certain conclusion from premises in mathematical matters—as that the three angles of a figure are equal to two right angles if that figure have those three angles only—I am under no such necessity in any question of moral or probable evidence; and on a question like that, different minds will differ, or the same mind, at different times. Again, I am under no necessity—even if I admit that I have no choice on moral evidence—I am under *no necessity* of exercising my volition in one given way, unless, indeed, you deny that I have ever any free-will at all. If so, and if you contend that, the same motives being presented to my volition, in the same circumstances, I must needs choose the same course, you may also contend, that, the same circumstances being presented to my judgement, in the same frame of the feelings, I must needs draw the same conclusion; and this may seem to make out an identity of Reason with Instinct: but this is the dispute of liberty and necessity, which every man's consciousness and hourly experience decide in favor of liberty, except in so far as it is a mere dispute about terms. But I really do think, that, allowing the question to be disposed of either way, there is a specific difference between Reason and Instinct: for, even upon the principle of necessity, suppose the man and the bee to be equally under the entire control of the premises in reasoning, and the circumstances or motives in willing, whatever it is, that each does, be it the necessary consequence of the circumstances, or not, is different in the two cases. Suppose, that if the bee reasoned, she would be under the necessity of drawing the same conclusion, and that if she exercised an election, she could not avoid choosing one course, and that it is the same with the man—it still is not only not proved that the bee does reason or choose, while we know that the man does, but the contrary seems proved.

A. How so? Were I to maintain the contrary, I should deny that we have any such proof. How do you prove the negative proposition, that the bee does not reason and will?

B. Observe, I do not say we have the proof of the negative, as clearly as we have of the affirmative. But, beginning with laying aside those actions of animals, which are either ambiguous or are referable properly to reason, and which, almost all philosophers allow, show a glimmering of reason; and confining ourselves to what are purely instinctive, as the bee forming a hexagon without knowing what it is, or why she forms it; my proof, of this not being reason, but something else, and something not only differing from reason in degree, but in kind, is from a comparison of the facts, an examination of the phenomena in each case, in a word, from induction. I perceive a certain thing done by this insect, without any instruction, which we could not do without much instruction. I see her working most accurately, without any experience, in that which we could only be able to do, by the expertness gathered from much experience. I see her doing certain things, which are manifestly to produce an effect she can know nothing about, for example, making a cell and furnishing it with carpets and with liquid, fit to hold and to cherish safely a tender grub, she never having seen any grub, and knowing nothing, of course, about grubs, or that any grub is ever to come, or that any such use, perhaps any use at all, is ever to be made of the work she is about. Indeed, I see another insect, the solitary wasp, bring a given number of small grubs, and deposit them in a hole which she has made, over her egg, just grubs enough to maintain the worm that egg will produce when hatched; and yet this wasp never saw an egg produce a worm, nor ever saw a worm, nay, is to be dead long before the worm can be in existence; and moreover, she never has in way tasted or used these grubs, or used the hole she made, except for the prospective benefit of the unknown worm she is never to see. In all these cases, then, the animal works positively without knowledge, and in the dark. She also works without designing any thing, and yet she works to a certain defined and important purpose. Lastly, she works to a perfection, in her way, and yet, she works without any teaching or experience. Now, in all this, she differs entirely from man, who only works well, perhaps, at all, after being taught; who works with knowledge of what he is about; and who works, intending and meaning, and, in a word, designing, to do what he accomplishes. To all which, may be added, though it is rather, perhaps, the consequence of this difference, than a separate and substantive head of diversity, the animal works always uniformly and alike; whereas no two men work alike, nor any man always, nay any two times, alike. Of all this, I cannot indeed be quite so certain, as I am of what passes within my own mind, because it is barely possible that the insect may have some plan or notion in her head, implanted as the intelligent faculties are: all I know is the extreme improbability of its being so; and that I see facts, as her necessary ignorance of the existence and nature of her worm, and her working without experience, and I know that if I did the same things, I should be acting without having learnt mathematics, and should be planning in ignorance of unborn issue; and I therefore draw my inference, accordingly, as to her proceedings.

A. Come, come, Master B., I begin to surround you, and drive you from your original position, maintained both now and last summer, about the impossibility of defining. Have you not, as nearly as possible, been furnishing a definition? At least, are not the materials of definition brought together, which you deprecated, and would have us reserve to the last?

B. Patience, good man—patience!

A. But, indeed, I sometimes can't help fancying, that it may be as well to take our observations upon Instinct from the operations and habits of large animals, at least, not from insects; because it is possible, that if we could see as accurately all the detail of the latter, as we do of the former, much of the marvellous might disappear, and we might be as well able to account for their proceedings, which now seem to us so unintelligible, as we are to account for those of the greater animals, which are clumsy and cumbrous enough, and rather appear to proceed from an obscure glimmering of reason, than from an inexplicable power guiding them unconsciously to work with the perfection which we ascribe to the bee. In a word, might not the cells be found to have as many imperfections, as great deviations from the true form, as any of the ox's operations have from perfect exactness, if either the bee were as large as the ox, or our senses as acute as the bee's? Has she not as great aberrations from the exact pattern, in proportion to her own size and to the instruments, her feet and feelers, which she works with? I throw this out, as a matter very fit to be settled in the outset, in order that our own reasoning may not proceed upon gratuitous assumption.

B. For the sake of ascertaining how far the working is as perfect as it appears, I admit the importance of your observation; but for nothing more. I deny that it affects the body of the argument at all; because that depends in no degree upon the perfection of the work. Thus, the proceedings of the solitary wasp, are just as good for my purpose, as those of the bee. Nay, the instinctive operations of the greater animals furnish exactly the same materials for reasoning, though they may not be so striking. However, to the point of your comparison—you must keep in mind, that we have applied the powers of the microscope to the operations of the bee. Now, without going to an instrument of the power of Torre's, which magnified the linear dimensions between 2000 and 3000 times, and consequently the surface above 6,000,000 of times, take the much more ordinary power of 400, which magnifies the surface 160,000-fold—nay, if you take a microscope of only a 90-times magnifying power, you will see the work of the bee in a straight line, exactly as you do that of a man with the naked eye. But, I need hardly add, that, if you only saw it a quarter as well, or with a glass that magnified 20 times, it would be enough; for then you would examine it as you do the beaver's with your naked eye. But further, all the difficulty you suggest proceeds upon a fallacy. The lines may not be exactly even, which the bee forms; the surfaces may have inequalities to the bee's eye, though to our sight they seem plane; and the angles, instead of being pointed, may be blunt or roundish; but the proportions are the same; the equality of the sides is maintained, and the angles are the same size; that is, the inclination of the planes is just—in other words, all the inequalities do not affect the proportions of the parts; for they are common to each thing compared with another; the axis running through the inequalities, (to speak more rigorously,) is in the true direction, and the junction of the two axes forms the angle of 60°, as accurately as if there were no inequalities. Now, then, the bee places a plane in such a position, whatever be the roughness of its surface, that its inclination to another plane is the true one required.

A. I suppose it is so; but at any rate, the solitary wasp, carrying the grubs in proper number, and placing them in the hole over the egg, or the bee placing her egg in the liquor, at the bottom of the cell, and making that cell of the length to which the worm when hatched will grow—she having never seen either the worm or the chrysalis—is sufficient for our purpose.

B. Not to mention the operations of the worm, itself, in spinning the cocoon, and making it precisely the size required to line or carpet the cell when expanded and applied to it—nay, the motions of the chick in the egg, which always begins at the same place, and moves itself on, in the same direction, chipping away till it effects its own liberation—all of which must be prior to experience, and without the possibility of teaching.

A. You desired me last summer to examine, with a view to the same point, the ducklings hatched under a hen, and then taking the water, without the possibility of *her teaching*. They have the form, web-feet, &c., which enables them to swim, and which a chicken has not. Their manner of getting into the water, I cannot say I well ascertained; but it is certain enough that the hen's proper brood would not have got in, and probably she would have succeeded in preventing them, though she might not be able to keep the ducklings out.

B. However, a more decisive case occurred to me afterwards: that of chickens hatched in the Egyptian ovens. I have lately seen an intelligent Bey and his Aide-de-camp, who gave me the whole process; and, as was to be expected, there is not the slightest difference between the conduct and motions, and habits generally, of these chickens, and of such as are hatched and brought up by hens. This fact, as well as the working of the chrysalis, in spinning the cocoon, and of the chick in chipping with its bill-scale, renders it quite unnecessary to inquire whether or not the honey-bee or social wasp works by instruction from other bees or wasps. That, however, appears to be impossible, when we consider that as many as thirty thousand young insects come from one nest, to teach whom, there are not old ones any thing like enough; and to teach whom in a few hours, or even days, to work as exactly as themselves, seems wholly impossible. The observation of cases, where such teaching is impossible, as in the chrysalis and unhatched chicken, at once removes all doubt, and precludes the possibility of supposing that the wasp's and the bee's architecture can be traditional, or handed down by teaching, from the first insects of the species that were created. Henceforward, therefore, we must assume, as part of the fact, that the cells of the bee are made without any instruction or any experience, and are as perfect, at first, as they ever are; which, by the way, explains another peculiarity of instinct—that it never improves in the progress of time. The bee, six thousand years ago, made its cells as accurately, and the wasp its paper as perfectly, as they now do.

A. Let us advert to one thing more, and, having settled it, the way may at least be said to be cleared for the argument, perhaps somewhat of progress even to be made in the inquiry. You have been speaking of Instincts, in the plural; of course you do not mean to be taken literally, as admitting more kinds of mental Instinct than one.

B. Certainly not; any more than when speaking of the mental faculties I admit of more minds than one, or more parts than one of a single mind. * * * * * Instinct is one and indivisible, whatever we may hold it to be in its nature, or from whatever origin we may derive it. This thing, or being, is variously applied, and operates variously. There are not different Instincts, as of building, of collecting food for future worms, of emigrating to better climates—but one Instinct, which is variously employed or directed. I agree with you, however, that we have now done something more, than merely clearing away the ground. We have taken a first step, or, if you will, laid a foundation. We have ascertained the peculiar or distinctive quality of Instinct, and that which distinguishes it from Reason. It acts without teaching, either from others, that is, instruction, or from the animal itself, that is, experience. This is generally given as the definition or description of Instinct. But we have added another peculiarity, which seems also a necessary part of the description—it acts without a knowledge of consequences—it acts blindly, and accomplishes a purpose, of which the animal is ignorant.

A. I pause here, and doubt of this addition. I perfectly admit the fact that it produces an effect, manifestly the object of its operation, and yet without knowing it, consequently without intending it or designing it. But there seems reason to think, that it always intends to produce some one effect, and does produce it—that it has some one purpose, and accomplishes it, and so designs something which it does. Thus animals are impelled by hunger to eat; their eating produces chyle, blood, and all that is secreted from the blood; yet they had no design to promote their own growth and preserve their own life. At least, they ate long before they had any such design, or any knowledge that such would be the consequence of gratifying hunger. So of continuing their species. May not the solitary wasp, for instance, have *its organs* and its senses so constructed, as to receive an immediate gratification from collecting and burying grubs? If so, her knowledge extended to one, the first, event, and she had the design in view of producing this event; though wholly ignorant of any subsequent event. The desire of the first event, the fact of that event being a gratification to the insect, was the means taken by the Creator of the insect, for making her do that which was to produce the important consequence, forming the real object in view, though concealed from the animal. Thus, we may conceive that the insect is endowed with an appetite for carrying grubs, and that this is so adjusted, in point of intensity, as to be satiated when just so many grubs are transported as will feed the next season's worm, which is endowed with the desire to eat these grubs, rejected as food by the parent insect. So the wasp's senses may make the flavor, or the smell, (for that seems all she enjoys,) of a living caterpillar, more grateful than of a dead one; and hence she takes those that will keep sweet till her own grub is hatched.

B. I do not deny the possibility of all this; although there seems something gratuitous in it, and we possibly never can know the truth, by any observations or experiments. I shall presently show why I do not think it would entitle us to erase this ignorance of what you would call the second event, or the object of the secondary design, from our list of the characteristics of Instinct. But in the mean time, I will mention what occurs to me on your objection, in point of fact. The instant that a solitary wasp is hatched, or a bee can fly, away they go to the spot where the caterpillars or the wax-yielding substances are to be found. What guides them through the air, to things they cannot descry or do not know the use of?

A. It costs me no more to suppose that there is some smell or other sensation to guide them—some odor, for example, which penetrates the air, and being grateful to them, makes them desire to approach the odoriferous body. Thus the bee smells the nectary of flowers; she flies to them, she sips, and the wax is secreted in her stomach. I grant you that I have more difficulty with her operation in using it.

B. You clearly have; for what should be the special gratification of that? We are admitting that she has no kind of knowledge that the cell is to be used in hatching and rearing the brood, any more than that a hexagonal figure, with a certain inclination of its rhomboidal bottom, is to enable her and her associates to employ the space and the wax in the way of all others most economical of room and work and materials; and so as just to accommodate the size of the unknown and unseen worm, chrysalis, or young bee, and no more—and also to suit its form.

A. I think I could suppose, also, in this case, that her desire of action—her love of motion—is gratified by the operation, and is satiated, by continuing that motion to a certain extent, where she stops.

B. But, allowing your right to make all these suppositions, equally gratuitous, one after another, and to extend them as the argument proceeds, and to relieve the pressure, as the fact pinches—see what it is that you must assume. The comb is constructed thus. Wax-making bees bring a small mass of this material, and place it vertically to the plane from which the comb is to hang down. Then, other bees begin to excavate, one on one side, another on the other, and they work with such perfect nicety, as never to penetrate through the thin layer of wax; also so equally, that the plate is of equal thickness all throughout, its surfaces being parallel. You must, therefore, suppose some repugnance at once to a plate ever so little thicker, and to one ever so little thinner than the plate's given thickness. Indeed, this supposition, which some naturalists have made, is wholly unsatisfactory, and shows no accurate regard to the facts, any more than their notion, (a most crude one,) that the hexagon cells arise from so many cylinders pressing on each other. The supposed instinct not to perforate wax, but to draw back when they come to a given thickness, is inconsistent with the fact; for the original plate they work on, is uneven and of different thicknesses on both sides, and there is no bee in the world, that ever made cylindrical cells. Huber has distinctly *shown*, from having observed them at their work, that they make them in quite another way; nor, indeed, if they did, could any pressure ever produce hexagons, and far less rhomboidal plates. The wax-worker's bringing plates of a given thickness, is also wholly incapable of accounting for the angles, that is, the inclination of the plates; for, supposing the bee to make a groove, (as she does,) and suppose she has some means of bisecting its arc by two chords, this only, with the thickness of the cake, would determine the depth of the rhomboid, and that can be easily shown not to be the rhomboid actually made. She therefore makes angles wholly independent of the thickness, not to mention, that, were we to admit that the cake's thickness governs the whole, we do not solve the problem; the difficulty is only removed a step; for then how is that exact thickness obtained? But this will not do, even to that extent; a great deal more is done by the bee, and a great deal more must be supposed, to make it conceivable that she has any immediate or primary intention. She works so that the rhomboidal plate may have one particular diameter, and no other, and always the same length, and that its four angles may be always the same, the opposite ones equal to each other, but each two of different quantity from the other two; and then, she inclines the plates at given angles to one another. Why is there such a gratification to the bee in a straight line, in a straight line at right angles to a plane, in rhomboids, in rhomboids with certain angles, —any more than in lines or planes inclining at other angles to one another? Why is the bee, after working for half a quarter of a line in one direction, to go on, and not take delight in a change of direction? If she goes on, why is she to be pleased with stopping at one particular point? Nay, why is each bee to take delight in its own little part of the combined operation? Why is each to derive pleasure from doing exactly as much as is wanted, and in the direction wanted, in order, that, when added to what others have before done, and increased by what others are afterwards to do, a given effect, wholly unknown to her and to all the rest, her coadjutors, may be produced?

A. It certainly is difficult to say. I can barely imagine the different bees so formed, that some inexplicable gratification may be the consequence of moving in one line, and making one angle, and that any other line or angle whatever, may be disagreeable to them. The concert in the operation of animals, seems to increase this difficulty much, always supposing there is real concert, without any arrangement, communication, or knowledge. No man ever acted so as to make his operations chime in with another's, unless he either had previous concert with that other, or both acted under a common superior, and obeyed his direction; and then the joint operation was that of this superior. But, suppose a man were compelled by some feeling he could not account for, and did not at all understand, to go at a given time, to a certain place, and with such speed as to arrive there at a given moment, and were to find another just arrived there, who came to meet him, without the former previously knowing of this,—we should have a case similar to that of animals acting in concert, supposing them to do so. There is, however, some doubt of this, as to the bees; for Huber has said that they all act in succession rather than cooperate contemporaneously.

B. I really can see no difference that this makes in the argument, as to concert. One bee brings wax and does not sculpture; another sculptures and does not bring wax: but the wax-worker brings just as much as the sculpturing bee wants, and at the very time she wants it; also, one works on the face, and another on the back of the same rhomboidal plate; and all so work as never to interfere with, or jostle one another, which is the perfection of concert, and can only among men be effected by discipline, which refers the whole of the different purposes to one superintendent, and makes his unity of design the guiding rule and impulse, because concert among the different agents is otherwise unattainable. But I own, I can see no greater difficulty thrown in our way, by concert, than by blind agency; supposing it blind as to both the events, and not merely blind as to the secondary consequence; and *your* supposition of a first event known and designed, the secondary being hidden from the animal, would, I think, account for a case of concert, as much as for any operations; for your hypothesis of sensations and impulses, would apply to concert. You might say, that each bee was induced by the gratification of doing a certain thing, to take a certain line at such a time; that what it did, should answer to what some other bee was by the like means induced to do at the same time. I see no difference in the two applications of this hypothesis.

A. I rather think the time makes the difference: at least in rendering an addition to the hypothesis necessary. For, though the gratification of bringing the caterpillars to its nest, will account for the solitary wasp doing what is also to serve the purpose of feeding its young next season, something more is required, than this motive, to make one bee act in concert with another; it is necessary, that there should be a gratification, not only in doing the thing required, but in doing it at the very moment required; so that both bees must be supposed to feel, at the very same instant of time, the desire of the gratification in question, and yet without any concert or communication. I hardly see how my supposition of sensations and pleasures or pains will explain this.

B. I all along have seen the greatest difficulty in your explanation; but does this consideration of time, increase it materially?—or rather, is it not in all cases part of the riddle which instinctive operations present to us? Thus, the solitary wasp acts, that is, according to your hypothesis, feels the given sensation, or derives the supposed gratification, at such precise time, that her acting upon it will suit the time required for the birth and growth of the worm. The bird breeds, but before laying her eggs, and without any knowledge when she is to lay them, makes her nest, and it is ready at the very time required. Therefore she feels the desire of nest-making at the proper moment. I will admit, however, that there is something still more extraordinary in two separate and independent insects feeling the same impulse at the same moment; and the difficulty is incalculably augmented, if twenty or thirty insects all have the impulse separately, but all at once, so as to act together. Indeed, I cannot help regarding your solution as not only a gratuitous hypothesis, for that it must needs be from the nature of the thing, but one hardly conceivable, and in truth as difficult to suppose possible as any other thing which we can fancy in order to explain the phenomenon ;—for instance, some invisible power or influence acting upon the animal, or upon the different animals at once. This is not at all more gratuitous, and it more easily explains the phenomenon.

A. Consider if there is really any such essential difference between the case of instinct which we have been considering, and any of the best known operations of men, as well as animals, where we are not wont to speak of instinct at all. Thus men eat from hunger, which they intend to satisfy ; but the consequential effect, not intended, is chylification, sanguification, secretion, and growth or sustentation of the body, as well as the effect intended, and immediately produced, of satisfying hunger. The mother eats things which satisfy her appetite, and that is all she cares for ; but those things also produce milk, which nourishes her infant, and that she never thought of. The time is also suited by the feeling. The hunger, gives the supply when the system wants it; the eating, produces the milk when the infant requires it. How does this differ from the other case ?

B. Much every way. The difference is wide and marked. In the cases you put, the mental instinct is confined to produce the effect intended; and having produced it, the mind stops there, and does nothing more. The powers of matter, its physical qualities, set in motion, do the rest, of course beyond our direct control, and unaided by us as unknown to us. But in the case of Instinct, the mind performs both parts—both the things which it knows and intends, and the things which it neither knows nor intends. The mother eats—Nature produces the milk without the least action of hers. But the bee not only gratifies herself, (if that is the cause of her architecture,) by the structure of the cell, but by her art, by her work, she does the other thing, also, that of providing a lodging for her young. It is, as if the mother, in your supposed case, were both to eat intentionally for satisfying her hunger, and at the same time, without knowing or intending it, were to make milk, by some process of internal churning. It is, as if, in eating, we at once chewed and swallowed, and also with our tongue or teeth or fingers made chyme, and then chyle, and then blood.

A. You must here distinguish a little, or rather you must take into your account a point of resemblance, which you are passing over. How can any one, even acting with design, affect matter in fashioning it or moulding it, except by availing himself of the powers, mechanical and chemical, belonging to matter? If I distil, it is by availing myself of the process of fermentation, and of evaporation, and of condensation. If I sow and reap, it is by availing myself of the prolific powers of heat and moisture in the process of vegetation. So even in processes where I seem to do more and Nature to do less; if I build, or carve, or weave, it is by availing myself of the qualities of cohesion and gravitation, and of the powers of the wedge in hewing, or of friction in polishing. Do not the animals, who eat; the mothers, who give suck after eating and thereby secreting milk; in like manner do part themselves, and, as to the rest, avail themselves of the powers of Nature in chylification, sanguification, and secretion? You perceive how much more nearly akin the cases are, than you have stated.

B. I am well aware of it; indeed, we are now coming nearly into the controversy about productive labor, which you and I have often amused ourselves with, as political economists; when I have always held, that it was a far less easy thing, than those, who discussed the metaphysical parts of that science, supposed, to draw the line between productive and unproductive labor, either by including manufactures, or only commerce, in the latter—and agriculture alone, or with manufactures, in the former, the productive class. Be it so: I am content, if there be as marked a distinction here, as between the labor which produces or moulds matter into a new substance, and that which only exchanges one thing for another, or defends the community, or administers justice among its members. But, in truth, we have, in our present argument, a specific difference, admitting all that you have urged, as to the affections and properties of matter being used by the animal in both processes. The great and broad difference is this. In the one case, as in the wasp carrying the caterpillar to its nest, which she does and means to do, or, if you will, gratifying her senses with the carrying, whatever instruments she works with, she does the thing knowingly and intentionally; she does it by means of gravitation and cohesion, but still it is she, her action, her will, her mind that does it. In the other case, that of leaving the caterpillar in the nest for months, she has done; she quits the work; nothing she does is at all conducive to the operation then performed by Nature; but what she did was all that could be done excepting by Nature. So the mother eats the galactigenous [milk-producing] matter, and then has done; Nature does all the rest. But there is this material difference in what the bee or the wasp does, that she finishes the whole operation voluntarily; it is, as if the mother were not only to bear children, but to prepare their clothes and habitation herself, and yet to do this without knowing what she was about, and while she intended to do, and thought she was only doing, some perfectly different thing. If, indeed, you put the case of a person ploughing and sowing for the purpose of strengthening his limbs or amusing himself, and not meaning any thing to grow, and also ignorant that any thing will grow, and yet choosing the seed which will grow, and sowing it at the right time to make it grow—then you merely put the case of Instinct in other words; and the one thing will be as difficult to explain as the other. And if one man should, by mere blind chance, do this the first time, and some other man, equally ignorant of what the use of thrashed wheat was, should reap and thrash it, and garner it away,—and if all men were to do so in two bodies, equally ignorant of what they were about, and yet both chiming *in with* each other in their operations, and both agreeing with the nature of things, then we should say this is the selfsame case with Instinct: but we should add, that this could not happen, without some overruling power not only giving those men the desire to stretch their limbs, but guiding them immediately how to do it; for there, as here, two designs and only one designer appears, and therefore some non-apparent contriver must exist and work. We may again put it thus—When a man brews or tills, he does something himself, and leaves the rest to the powers of Nature. So when a mother eats or drinks, to gratify hunger or thirst, she has done; Nature does the rest, namely, supports her body and secretes the milk for her young. But the bee, or the wasp, does the whole. They use the powers of matter, indeed, as the farmer and brewer do, and as the mother does, in the operation, itself, performed by them, namely, breaking the ground, throwing the seed, steeping the grain, eating the victuals; —but the insects finish the operation, and leave nothing to be done. The solitary wasp has completed a cell and provided food; the young have only to eat it. The bee has completed a cell with food likewise. Neither mind nor matter on the part of either insect has any thing more to do; the thing they intended and knew all about, is done, and in doing that thing, they did something else, neither known to, nor intended by them. They only used the powers of matter, in doing the thing they intended. They did not leave any natural powers, to do the other thing, not intended by them; but they did it also, though unintentionally. Man does what he intended, but he does nothing more;—Nature does the rest, both where he intended it, as in ploughing or brewing, and where he did not, as after eating to satisfy his hunger. In the bee, it is like a whole manufacture completed by the animal, though unintentionally; as if a man were to make a skein of fine lace while he only meant to amuse himself with twirling the bobbins, or playing with his fingers among the flax or the threads.

A. I certainly think we do get to something like a specific difference. But compare the work of the insect with certain chemical processes. If you mix, or if any natural process mixes, certain salts, and the liquor is left to evaporate, there are formed crystals, say hexagons, as accurately as the bee forms her cells. Also certain bodies move in lines, which have properties similar to the angles in the comb, as a heavy body falling through the shortest of all lines. There is, no doubt, a difference here, and a marked one; yet it is as well to consider it.

B. Doubtless there is a difference, and the greatest possible. These forms are assumed, and these motions performed: for instance, a stone falling to the ground in the shortest line, or the planets, all arranged respecting their masses, the direction of their motions, and the inclinations of the planes they move in, so as, according to Laplace's beautiful theorem, to preserve the system of the universe steady, by affixing limits, maxima and minima, [greatest and least, or highest and lowest,] between which the irregularities oscillate; all these things are the direct and uninterrupted agency of the property, which the Deity has impressed on matter at its creation; perhaps, of the laws which His power perpetually maintains. But they are wholly unconnected with any animal workmanship, of any kind; they have no subordinate mind to guide them; nor can any act of ours, or of any animal, affect them. On the contrary, in all our operations, we must conform to them.

A. Unquestionably it is so; and this is the distinction, and the broad one. But then it follows, from the preceding deductions, that we must consider in the works of Instinct, the animal acting as an agent, though ignorantly and unintentionally,—a tool or instrument blindly used to do a certain thing, without its own knowledge or design; and the tool being a living thing, the mind is the instrument. In the case of matter, the matter is the instrument, blindly serving the purpose, by obeying the physical law. In our case, the mind is the instrument, and obeys the mental law as perfectly and as blindly.

B. There is one thing, however, always to be considered. We have hitherto been viewing Instinct alone, and arguing as if animals always acted by it, and never otherwise. Now this is quite impossible, at least in the sense in which we have taken the word Instinct. There may be some doubt if we are right in so limiting the term, though I have a very clear opinion that we are. Paley, and all, or almost all others, define Instinct, to be a disposition or acting, prior to experience, and independent of instruction. But among other objections, there is this one to the definition, that it amounts to saying "an acting without knowledge," and yet does not say it. There may be no experience, and yet no Instinct, *e. g.*, we may act on the information of others; but then what shall be said of the information given by reasoning, that is, by our inferences from our own thoughts? This is plainly not instruction. Is it experience? If so, the definition seems only to say, that Instinct is any thing that is not reason, in other words, that Instinct is Instinct. But I apprehend, when we speak of instinctive operations, we always have an eye to some end which is blindly served by the act—some act done by the animal, in which he does what he does not mean, and in doing which, he is a blind instrument.

A. How is it, when we speak of instinctive desires?

B. I should say, we then mean something different from merely animal or natural desires, for that would make every thing instinctive. We mean desires which are subservient to some purpose towards which they move: some end beyond the doing the act, seems always involved in our notion of Instinct. We do not call mere moving, yawning, stretching, instinctive; and when we speak of sucking or eating, and the desire or power to suck or eat, as instinctive, it is surely with a regard to the subserviency of those operations to support life that we so term them. If they did nothing for our frame, we might call them natural, hardly instinctive.

A. But be this as it may, no one can doubt that animals, if we allow them to have these Instincts, and to act for ends unknown to themselves, have other actions of a kind resembling our own, and quite distinguishable from what we have been calling Instincts; therefore it signifies little, *whether* or not we are right in giving the name to actions, accomplishing undesigned and unknown purposes, provided we keep that definition in view. These animals also have other actions, where they both know, and intend, and accomplish, their definite object.

B. Undoubtedly, they have many such, in which their operations of mind and body cannot be distinguished from our own. Now whether these are under the guidance of faculties like ours; whether they have reason; whether they have faculties differing from our own, in kind, or only in degree; we need not, at present, stop to inquire. It is quite enough for us, that they have two kinds of operations, one which we agree to call Instinctive, distinguished by the ignorance of the object, and want of intention; the other both knowingly and intentionally done; so man, acting almost always rationally, also acts, in some rare cases, unintentionally—chiefly in early infancy.

A. There may be instinctive acts, with knowledge, and there may be acts not instinctive, without knowledge. Does not this break in upon the definition, which excludes knowledge, as well as design? Many parts of human conduct seem to be guided by Instinct, and yet with knowledge.

B. This would no doubt overturn the definition, provided it be clear that "*knowledge*," and the "*presence of knowledge*," are here used in the same sense as in that definition. But we must make a distinction. There is a knowledge of some *end* or *object* in view, and a knowledge of the *means* whereby that end or object is to be attained; in other words, of the *mode* of *operating*—of the *process*. There is also a distinction to be taken between instinctive *desires*, and instinctive *operations*. The objection you have now made, refers to the former—to desires; the latter—the operations, are chiefly referable to the great question respecting the controlling mind, or actual interposition of the Deity, to which we are approaching; but it also refers, in some measure, to the objection which you raise. Knowledge of consequence, comes within the description of object or end; and if there be no intention to attain an end actually pursued, there can be no knowledge of it, and conversely, if there be no knowledge of it, there can be no intention to attain it. Take any instance of what you call human instinct, as hunger; this is a desire, and its gratification may be pursued without any knowledge of, and consequently without any view to, the consequences of making chyle and blood to support the individual. As far as the mere gratification of the desire, or supplying of the want goes, we may be said both to know what we are doing, and to intend or mean to do it. We are attracted by our senses, that is, by the effect of our senses on our minds, to do certain things; and this is called instinctive acting, I apprehend incorrectly. It is *natural* desire, but why instinctive? When we say Instinct, do we not mean something beyond this? Desires may be subservient to Instincts; but are they all we mean by Instinct? They may lead to the attainment of a certain end; they may be the way in which Instincts operate; but are they themselves Instincts? If two foods are presented to an animal, a man, for example, who knows nothing of either, and he is impelled, without knowing why, to take the one and reject the other, and the one is wholesome and the other a poison, we at once call this the operation of Instinct, which some define to be knowledge without instruction or experience, but which I have wished rather to call mental action without knowledge, or at least independent of knowledge. So in Galen's beautiful experiment on the kid just born, having been immediately taken from the mother, and which of course had never sucked, when, upon many shallow pans with different liquids being placed near it, the animal preferred, at once, the pan containing goat's milk. If the reason for the preference is some greater gratification of the senses, or that the one food is pleasing, for instance, in smell, fragrant, and the other offensive, this may be the mode taken by Nature to make Instinct operate according to your former hypothesis, which we have been discussing at large; and we certainly cannot tell that such may not, in all cases, be the mode taken by Nature for working to the same end. It seems, however, eminently unlikely that the whole operations of bees, for example, should be owing to the pleasure their senses receive from one particular form and proportion alone, and a repugnance to all others, because of their being disagreeable to those senses. But do we not, in all cases, mean, by using the word Instinct, to point out the unknown connexion between the thing done and something else of which the animal—the agent—is not aware? I grant you that we speak of Instinct of hunger; but is not this merely a way of saying, and do we not mean, merely desire of food, the gratification of which is a natural propensity, and known and felt by us to be such? Thus it is an Instinct, which enables animals to prepare a nest, and have it quite ready at the very time they are to want it for laying their eggs in. We always seem to have the *motive*, the *end*, and the *blind instrumentality*, in our view, when we speak correctly of Instinct. I may intend to do a thing, and know both the object in view and that portion of the operation, or process, which depends on me—*e. g.*, to eat, for the purpose of making chyle. My ignorance of that process, with which I have nothing do, would not make the operation of mine be called an Instinct. Indeed, even if I eat to satisfy hunger, without any design of supporting the system, this act is not instinctive, except in so far as doing and meaning one thing, I am doing another thing, ignorantly and unintentionally.

A. I think we have got as far as we can in these preliminary discussions and observations of Facts, and may now proceed to theorize and infer.

B. However, we are come, or coming, to a part of the subject, where we should be among our books; for we shall now have to look at them, in proceeding further. At least, it is as well we should observe what has been held on this matter by philosophers. So we will adjourn for the present; and resume our conversation in the library, if indeed you, who are accustomed to Althorp and Spencer House, can condescend to call any thing in this part of the world by that name. We commonly, from feeling this modesty, name it the Book-room.

A. And I dare say, also from your love of the Saxon *idiom*.

B. Possibly; though I would that our good old English never suffered more havoc than by calling Book-rooms Libraries. I expect to outlive it, as Sergeant Maynard said he had nearly done the law, with the lawyers.

BOOK, OR DIALOGUE II. INSTINCT.—(THEORY.)

HAVING thus far carried on our discussion in the open air, we removed, towards the afternoon, to the library, and there conveniently pursued the subject, which greatly interested us both.

B. The manifest difference, between Instinct and Reason, which we have been observing, and its regular and constant action, always the same, and never improved, but never different, indeed apparently incapable of improvement, was probably the consideration, which induced Descartes to consider animals as machines.

A. I am aware that this is commonly said of him. But I know not how that great man could really have held so untenable a position. Did he really consider them as mechanical contrivances—as mere physical substances, without any thing answering to what we call Mind?

B. He is always so represented; but when you examine his own statement closely, you really find that this is an exaggeration, and that his doctrine differs not very much from that commonly received. As has oftentimes happened to others, his sentiments are rather taken from the statement of them by those who were controverting them, than from his own words.

A. Where are they to be found?

B. Look here—you have them in the short treatise on Method, the introduction to his work on Dioptrics and Meteors. He dwells on brutes having no gift of speech, which yet requires very little reason, he says; and therefore he concludes, not merely that they are less rational than man, "sed plane esse rationis expertia," [but clearly destitute of reason.] Thus far, no doubt can exist; he only gives a very common opinion on the subject, though an opinion controverted by some, as I shall hereafter ask you to discuss: but it forms a head distinct from our present inquiry. But a little way further on, he proceeds to illustrate his position, in a manner which has given rise to the notion in question. "They do many things, even better than ourselves," he says, "but this does not prove them to be endowed with reason, for this would prove them to have more reason than we have, and that they should excel us in all other things also; but it rather proves them to be void of reason, and that Nature acts in them according to the disposition of their members, as we see a clock, which is only composed of wheels and weights, can measure time, better than we can with all our skill." He goes on to show that the interests of virtue are greatly injured by the belief, not that brutes have souls, but that they have souls like our own; and that therefore we have nothing more to hope or fear, in a future state, than flies or ants; whereas he had shown our souls to be by their nature independent of the body, and therefore not mortal, like and with it. All this, you perceive, is any thing rather than the doctrine, that brutes are mere machines.

A. But where do you find the adversary's representation of it which you mentioned?

B. Here, in this other and very curious volume, containing his Correspondence with many learned persons, and some less learned, as Christina, Queen of Sweden, and the Princess Elizabeth, Electress Palatine, and stock of the present Royal family of England, to whom he writes, among other letters, one on her brother Charles the First's execution—which, to console her, he praises as more glorious than an ordinary death—pulchrior, felicior, et dulcior, [more glorious, more happy, more delightful.] (*Epist. Pars* I., *Ep.* xxvii.)

A. Does the Princess enter on the question of animals?

B. No; she seems to have been ailing with fever, and, having been light-headed, she applies to the philosopher, to explain to her how in the night she felt an irresistible desire to make verses; this he courteously explains, (after saying it reminded him of a similar anecdote, related by Plato, of Socrates,) that it is owing to the agitation of the animal spirits, which in weak brains produces madness, but in strong ones, only a genial warmth, leading to poesy, and thereupon he holds her Serene Highness's case, to be "ingenii solidioris et sublimioris indicium," [an indication of a more substantial, an elevated genius.]

A. Upon my word, I shall begin to think a person, who could thus theorize, as well as flatter about animal spirits and Serene Highnesses, was capable of shutting his eyes to the most ordinary facts, and believing brutes to be machines.

B. Do not undervalue this great man: he is the true author of all the modern discoveries in mathematics. He made the greatest step that ever man made, since the discovery of algebra, the time of which is lost in the obscurity of remote ages; I mean his application of algebra to geometry, the source of all that is most valuable and sublime in the stricter sciences and in natural philosophy. But assuredly his physical and psychological speculations are much less happy; although it was no mean fame to be the author of a treatise, the answer to which, was the greatest work ever composed by man—Newton's Principia. But I was coming to the controversy on Instinct. An ingenious clergyman, of Cambridge, Henry More, objected to the doctrine of the great philosopher, as laid down in that treatise to which we have been referring, on Method; and he began, by describing the doctrine as denying sense and life to brutes. This he repeats in various ways, and argues against, as the doctrine of Descartes.

A. Nothing, in what we have read out of Descartes's own writings, justifies this. Is there any other passage to which More can allude?

B. He refers, expressly, to the passage in the 'Tractatus de Methodo,' and discusses the argument there given from the want of speech. But there remains a letter of Descartes, to a certain great personage, in which he repeats the doctrine of the treatise at somewhat greater length, but using the same comparison of a clock, and using it as a comparison. His whole contention is, that they, the brutes, have not reason, like us, which he sometimes terms "intellect," or thought. But that he means reason, and does not mean to assert that brutes are machines, seems plain from this, that in the same passage, he allows them natural cunning, or craft, as well as strength. This is any thing rather than describing them as mere machines.

A. But what does Descartes reply to his correspondent's letter, in which he represents that to be his doctrine? Does he object to Mr. More's statement?

B. Why, singularly enough, he does not, in distinct terms, repudiate it, though this may be owing to his supposing, that, as he had used the comparison of the clock, Mr. More is also speaking in the same terms, especially as Mr. More had professedly used figurative language, and spoken of Descartes's cutting off all animals as with a sword. But he certainly speaks in this answer, (*Part* I. *Ep.* lxvii.,) more strongly than elsewhere. "I have diligently inquired," says he, "whether all the motions of animals came from two principles, or only from one; and as I find it clear that they arise from that principle, alone, which is corporeal and mechanical, I can by no means allow them to have a thinking soul. Nor am I at all hindered in this conclusion, by the cunning and sagacity of foxes and dogs, nor by those actions done by animals from lust, hunger, or fear; for I profess to be able easily to explain all these things by the sole conformation of their limbs." He adds, that though he sees no proof of the affirmative proposition, (of their having a thinking principle,) yet he also admits there is no proof of the negative; and he then comes back to his favorite topic, of its "being less likely that worms should have immortal souls, than that they should move like machines;" and again refers to the want of speech.

A. How any man, who ever saw dogs in a field pointing, or greyhounds chasing a hare, or still more, dogs sleeping and manifestly dreaming, without any external object to excite their senses or motions, or who had observed birds taught tunes, could ever suppose them mere corporeal or material mechanism, things made of dead matter and without life, I cannot comprehend.

B. The best of it is, that he positively affirms they have life. The letter I have just been reading from, and in which his doctrine, if any where, is stated the most explicitly, concludes by warning Mr. More not to suppose he denies them life; and it is remarkable that he uses the very words *vita* and *sensus*, [life and sense,] which Mr. More had represented him as refusing to brutes.

A. Then what does he mean by life and sense?

B. He goes on to tell you, "uptote quam in solo cordis calore consistere statuo,"*—mistaking the indication or effect of life, for life itself. He adds, "nec denego etiam sensum quâtenus ab organo corporis pendet."† Now, can it be that Descartes really supposed he had taken a tenable distinction, here, between mind in man and in brutes? Or that there could be any perceptible difference, between a machine, endowed with life and sensation, and capable of imitation, of learning, and of much cunning—and a body animated by a mind? To speak of sensation, as depending upon the corporeal organs, is either unintelligible or it is a begging of the question, and the very same definition might be given of our own sensation;—nay, is given of it by the materialists, who hold our mind to be the mere result of a physical organization. Yet with these, Descartes differs more, indeed, than with all others.

A. I cannot help thinking, on the whole, that it is very possible this great man may have only meant to deny the brutes a reason, or mind like ours, a power of ratiocination, and not to consider them as mere machines. But I am clear of one thing, that if he did mean the latter, a more untenable doctrine, never was broached upon this, or indeed upon any other subject.

B. We may, therefore, I conceive, pass over this theory, altogether. But another and a greater man, has been so pressed with the difficulties of the subject, that he has recourse to a very different supposition, and instead of holding the Deity to have created brutes as machines, without any mind at all, he considers their whole actions as the constant, direct, and immediate operation of the Deity, himself. Such is the doctrine of Sir Isaac Newton, which is saying enough to prevent any one from hastily rejecting it, or rashly forming his opinion against it.

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* [Inasmuch as I consider life to consist in the warmth of the heart alone.]

† [Neither thus far do I deny the dependence of sense upon bodily organs.]

A. Does he not mean merely to derive the actions of brutes, from a perpetually superintending and sustaining power of the Deity, as we ascribe the motions of the heavenly bodies to the same constantly-existing influence? He probably only means that the brute mind, having been created, is as much under the Divine governance as the material powers, qualities, and motions are; in other words, that mind was created, and matter was created; and that still the actions and passions of both, are constantly under the guidance of the Creator. So that Sir Isaac Newton would no more deny the separate existence of the minds of brutes, than he would the separate existence of their bodies, or of the heavenly bodies.

B. Here are his own words. The passage occurs in the famous 31st Query, or General Scholium to the Optics;* and you see, that, after recounting the structure of animal bodies, as proofs of design, he adds, "And the instincts of brutes and insects can be the effect of nothing else than the wisdom and skill of a powerful, ever-living agent, who, being in all places, is more able by his will to move the bodies within his boundless uniform sensorium, [seat of sense,] and thereby to form and reform the parts of the universe, than we are, by our will, to move the parts of our bodies." He proceeds to guard the reader against a supposition of the Deity being the soul of the world, or of brutes, or of His being composed of members or parts, stating that He only "governs and guides all matter by his prevailing power and will." So that you see he draws the distinction between the mind or will of men, which influences the motions of their bodies, and the influence which moves brutes; plainly enough referring the latter to the Deity himself, as the *primum mobile*, [first cause of motion,] or actuating principle; for he allows that the kind of ubiquity, or universal action, to which you refer, applies to our bodies, and I presume to our minds, also, which were created and are sustained by Him. Of that, no doubt can exist, because elsewhere he has laid down, as clear, this ubiquity, called, as you know, *essential* ubiquity, to contra-distinguish it from *potential* or *virtual*. You find this plainly stated in the Principia. Therefore it is quite manifest, that, in here treating of Instinct, that is, of the operations of animals, he considers the Deity's action, as different from that general direction which he ascribes to Him over matter and mind, by his essential ubiquity. In other cases, He acts on matter and mind; and, in the case of mind, He acts on matter mediately or through the agency of mind, which mind He moves. But here, He acts, according to Sir Isaac Newton, directly on matter, and is the moving and acting principle of animals; and such has generally been the construction put upon his words, as you have them here in the 31st Query. It has been so stated by so popular a poet as Pope, and also, though with less precision, by Addison. The former, makes the distinction in his Essay on Man, between brutes as only having volition, which, in them, acts for both willing and reasoning; while men have the double faculty. He expresses himself with his wonted felicity:—

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* There is nothing more admirable for extent and generalization of view than this 31st Query. The happy conjecture respecting the nature of the diamond, in the 2d Book, (*Part* II. *Prop.* 10,) does not surpass the wonderful sentence in the query, where Sir Isaac Newton classes together, as similar operations, respiration, oxydation, and combustion. These have since been discovered to be the same process. In Sir Isaac Newton's time, their diversity seemed as great, as that between the diamond and charcoal.

> "See then the acting and comparing powers,
> One in *their* nature, which are two in ours;
> And Reason raise o'er Instinct as you can,
> In this 't is God that acts, in that 't is Man."
>
> *Essay, Ep.* iii.

Addison, in his 120th Spectator, after giving many instances, in which he jumbles together Instinctive and Intelligent operations, concludes with the remark, that "they can no more be explained, than gravitation can; and come not from any law of mechanism, but are an immediate impression from the first Mover, and the Divine energy acting in the creature."

A. This dogma of Newton is certainly great authority—the greatest human authority. For it is the opinion—and, regard being had to the awful nature of the subject, as well as the contemplative and religious nature of the man, it is probably the well-considered opinion of the greatest inquirer into Nature that ever existed, and whose conjectures have been almost as happy, and are certainly quite as marvellous, as his complete discoveries.

B. Observe too, that it is the opinion of his maturer years. The Scholium to the Principia was added in the later editions; when written, does not clearly appear, but the second edition was published in 1713, and the third as late as 1726. The 31st Query to the Optics, was added at a time which can be fixed better. The first edition of the Optics, published in 1704, had not the queries. The second, published in 1717, had them; and the third edition was corrected by the author's own hand, a short time before his death; from which corrected copy, the one I am now citing was printed, in the year 1730, after his decease. But as he first published this passage in 1717, and was born in 1642, he was then in his 75th year, and had long before, made all his discoveries.

A. I quite agree, that, as far as mere authority goes, no opinion ever had so great a weight; nevertheless we have the same illustrious man's authority, and example, too, to teach us, that it is by our own reason alone that we ought to be guided in philosophizing, and we must bring to the test of that canon even *his* best considered opinions.

B. This, I, of course, freely admit. Let us, then, examine, a little, this doctrine of immediate interposition; which regards the work of the bee, for instance, as the direct and immediate operation of Divine wisdom and power.

A. I need hardly warn you against being seduced by another bias, as powerful as Sir Isaac Newton's authority—the disposition we must have, if possible, to believe in a doctrine, which, by exhibiting the finger of God as perpetually moving and working before our eyes, seems to bring us constantly into His presence, as if we saw a perpetual miracle wrought, and almost enables us to commune with the Deity, as the Patriarchs did, of old. The gratification to us, as men, of reaching this position, should not make us, as philosophers, open our ears the more readily to any unsound or inconsistent reasonings, assume facts on slight grounds, or, passing over flaws in the argument, receive easily erroneous conclusions from what we see.

B. Again I entirely agree with you. Far from making greater haste to reach a position so delightful, I should take the greater care of my steps, that I might not slip and fall by the way; for that the road is slippery, the light glimmering, and the route over high ground, leading through precipitous passes, must, I think, be admitted freely. But let us step on cautiously as we have hitherto done.

A. We left off, with the deduction that brutes act from a principle, a thinking principle, a mental principle something different from their bodies and from surrounding objects, but that they act towards an end of which they are ignorant, and accomplish that end, without design, though very possibly they may also, in so acting, accomplish some intermediate end, of which they are aware, and which they intend to attain.

B. We may add another thing to the proposition. The end which they accomplish, blindly and instinctively, is far the more important of the two, admitting that there is another and intermediate one. For suppose your theory to be correct, that the solitary wasp gratifies some sense in carrying caterpillars, and the bee, in making hexagons and rhomboids, it is plain that this is a very trifling matter; it neither feeds, nor clothes, nor lodges her, nor her brood; whereas, the purposes to which those works are subservient are the continuation of the species of the insects respectively—the greatest and most favorite end in Nature.

A. True; and you may add another thing, which I allow, even if my theory be ever so certainly correct—that the only possible use of the intermediate end, is the accomplishment of the other end; for, if you grant me that the wasp carries caterpillars, and the bee makes geometrical figures, to please themselves, or gratify some sense, it is of no importance that either should receive that gratification; its only use is the unknown and unintended consequence, of providing for the unborn issue.

B. We are now, then, arrived at a very important height, whence we may survey the subject, correctly and advantageously.

A. Let us be quite sure, that we have left no obstructions, or rather that we have passed over nothing material; that we have left no objections in our rear, which may rise up and mock any inference we now draw. For instance, are all our facts clear? As to the bee's architecture, some have questioned the theory. I have heard it said, that what seems so perfect a structure, and so judicious a dividing out of space, so as to save room and work and material, is only the necessary consequence of placing a number of cylindrical or globular bodies together; that if you blow many soap-bubbles in a basin, they will, by their weight and pressure, settle into hexagons.

B. There never was any thing more absurd, than what some, calling themselves philosophers, have said, without a moment's reflection on this subject. No less a name than Buffon, may be cited, for such nonsense. There are two decisive answers:—*First*, the soap-bubbles will not make hexagons, although your eye may see straight lines, formed by their intersections, but not one hexagon, the least like the bee's, will you find in all the foam; and *next*, there is not a single globe, or cylinder, or any figure like it, ever made by any bee. Huber has seen them, or rather had them carefully observed, when at work; they first make a groove, and then form its walls into planes, and all the rest is a making of planes and angles one after the other, without any circular figures at all. So, some one finding the eye of the bee to be a network, when greatly magnified, and each mesh a hexagon, thought he had found out why the bee works in that figure. To which, the answer was obvious, that men and other animals having circular pupils should, by parity of reason, work in circles. But another answer was just as decisive; that the light, entering by a hexagon almost infinitely small, no more helps the bee to that figure, than if it entered by a circle or a square. Its paws and feelers are to work. Nay, suppose even it had a small pattern hexagon ready made, would its working a large one, on that model, be at all less wonderful? Not to mention that the hexagon is not the greatest wonder; the rhomboidal bottom of the cell, and the angles which its three plates form with each other, and with the walls, are the wonder, and no one pretends to account for that. I pass over the form of the limbs; nothing can possibly be deduced from them, in the smallest degree fitted to aid the bee in her marvellous work.

A. Have not some skeptical inquirers thrown other doubts upon the mathematical part of this great wonder? I think I have heard something of the kind, as if Maclaurin, or whoever was the discoverer, had rather been fanciful, or over-refining, and that the bee had turned out to be not so good a geometrician as they had supposed.

B. Here is a sample of those doubts—though they are not, indeed, like Newton's sound conjectures, stated with the modesty of doubts—but somewhat dogmatically. It was the celebrated Maraldi, who first measured the angles, and found them to be 109° 28′ and 70° 32′ respectively. Reaumur afterwards set a young mathematician, pupil of Bernouilli, called Kœnig, to find what were the angles that made the greatest saving of wax, and the result was by his analysis 109° 26′ and 70° 34′, being within two minutes of his own measurement, which measurement he had not communicated to Kœnig. But it turns out, that the bee was right, and the analyst wrong: for, by solving the problem in another way, I find that he erred by two minutes, and other mathematicians, with whom I have communicated, distinctly find the same thing, and we have also found how the error crept in.

A. These angles must have been very nicely measured; for the difference of two minutes, or the 2000th part of the lesser angle, is very small indeed. How were the angles first ascertained?

B. Maraldi was a most accurate observer, and he gives the angles, as I have stated, 109° 28′ and 70° 32′; and he gives them to differ with the result of Kœnig's calculus, which was made after Maraldi had measured—so he could not have fancied the amount. But I have reduced it, from measuring an angle, to the easier operation of measuring a small line. If those are the angles, then it follows that the breadth of the rhomboid is exactly equal to the side of the hexagon, and you find it appears to be so. Also, if those are the angles, the rhomboidal plates are inclined to one another at the angle of 120°, that of the hexagon; and you find they do not differ when you place them together, one within the other. However, I admit that this is not a very close admeasurement of such small differences; and I presume Maraldi must have employed a micrometer. I have used one to compare the breadth of the plates and sides, and I certainly can find no inequality. At all events, the bee seems entitled to the benefit of Maraldi's previous measurement, which had been thought to put her in the wrong, now that the analyst, and not she, has been found in error. This, however, is nothing to what follows. A Berlin academician, thinking, I suppose, to do a kindness by Frederick II., objected to the bee, that though, if the dimensions of the cell be given, the saving is as I have stated, yet there is such a great waste of wax, arising from those dimensions, as proves the saving of wax to be no object. He sets himself the problem of what he calls a *minimum minimorum*, [the least of minute things;] namely, to find the proportion, between the length and breadth of the cell, which saves most wax; and he finds it something quite wide of the actual proportions. Now, I went over this analysis, and again found the bee right, and the philosopher at fault; for he had wholly left out the hexagonal covering of the cell's mouth, which, whether for brood or honey, there always is; and I found the actual, or bee's, proportions to save more than the academician's, when this was taken into the calculation. I moreover found the sides, to be so much thinner than the bottom, that a shallow and wide cell would have cost more, even independent of the covering at the mouth. Again, he admits the form chosen, to suit the bee's shape, which the form he calls a true minimum, never could; but I show, that it saves wax as well. Lastly, I have solved another problem, of a like kind, namely, to find the angles that save most of the fine, or difficult work, which is the angular or corner-working evidently, and that also is the thickest part of the work necessarily. I find the solution gives the very same angles which the bee uses, and which also save wax, in the other view. So that she has hit upon the very form, which, in every respect, is the most advantageous, and turns out to be, on all grounds, right; as, indeed, we might well suppose, when we recollect who is her Teacher.

A. All this is most satisfactory, and it was worth stopping to state it. However, as we have made a pause, before our next advance, it may be just as well to stop, for a moment longer, in order to consider what the bee's operation really is. How we should go to work, had we to build cells, is plain enough. Suppose we had discovered, which we should do by mathematical investigation, the proper form, the due proportion of the width to the length, and the proper angles of the bottom or roof—then we should have drawings and plans; and by these, we should either cut our planks, if the structure were of wood; or if it were of stone, which more resembles the bee's materials, and is, be it observed, much more difficult and complicated to work with, we should, by those plans, and by models or frames, run our courses. It would be a nice and difficult work to make this masonry, and would require the builder, both in hewing the stones, and in putting them up, to follow the details of the plan in its parts, and without any regard to the general figure or result. He would be wholly unable to succeed, if he looked to that; all his building would be awry and out of the required figure; his only chance is, to make his plan exact, and his model-frames suit it; and then, he has instruments and tools, plumb-lines, squares, and plumbs together, in order to raise his perpendiculars. By these, he proceeds, for he cannot trust his eye or his hand, a moment, beyond the mere adjusting his work to his instrument and his plan. Now the bee confessedly has neither plan, except what is in her head; nor any model, at all, whereby to guide her hand; nor any instrument, to adjust her work to the plan in her head; nor any tool to work with, except her paw and her feeler, which is as her eye, in doing the work. Then how does she work?

B. Certainly, this is a most important consideration. We cannot trust our eye or our hand an instant. We have no exact perception of the line, and no steadiness in pursuing it. We have recourse to plans and instruments, because we cannot form our lines by volition, that is, by having a form in our mind and by making our hands follow that form. We therefore must first lay it down sensibly, and then guide our hands by material means. Thus we have no power of forming a dome, an arch, or a circle, or a perpendicular, or a level, or even a straight line at all, or any one line or form which we conceive in our mind. Far from being able to follow these lines, in great works, as roofs and walls and excavations, we cannot even represent such forms, on a sheet of paper, by our handiwork. If we could do this, we should work like the insect, who acts immediately, and not through the instrumentality of means. Unable to execute any purpose of our minds, as she does, we have recourse to instruments. We endeavor, as far as we can, to reduce every thing to a physical or material process; to exclude mental operation or agency altogether; to make the whole a material, or, as we call it, accurately enough, a mechanical operation. Reason, no doubt, has taught us to do so; but it has taught us a general rule; and there is little or no reason, little or no operation of the mind, in its application to the particular cases. On the contrary, the use of the rule or method is, that it precludes the operation of the mind as much as possible, and makes the whole physical, or nearly so. To take an instance—we reduce, by engraving or printing, the whole operation of drawing a picture, or writing a page, to turning a lever, which does the work for us. So in building, though there is less mechanical facility, we guide our hand by the instruments employed and the lines drawn, making the operation as mechanical, as little mental, as possible. The bee's operation is all mind together. She has no plans, no instruments, no tools. It is as if by waving our hands among plastic materials, we formed walls, and domes, and columns, and never deviated a hair's breadth from the perfectly accurate plan. I am very decidedly of opinion, that this essential difference between the works of Reason and Instinct is of the greatest importance to our inquiry; for nothing can more show the peculiarity of the instinctive operation; or more prove that the mind of the agent is, as it were, the machine, and the instrument, to perform the work, and to perform it with an unerring certainty and with absolute perfection.

A. Does this, which appears to me, as it does to you, a most important consideration, bring us at all back towards the ground of Descartes, which we had passed over, as forming a position wholly untenable; I mean, that the insect is a mere machine, fashioned by a perfectly skilful mechanic, and wound up to perform the functions which he designed?

B. Certainly not. The proposition which we have just been deducing from the facts, is rather of a kind the very reverse; it affirms that the insect's mind performs the whole operation; it makes the insect's mind, the machine, if I may so speak. But let us see to what it also leads, or seems to lead us. We perceive there is mind at work, action exerted, effect produced; but we see that the mind is quite unconscious of the effect, and that the action works to a purpose which the mind never contemplated. There is a thing done, an important and rational thing done, but done by an agent who neither intends nor knows any thing about it. Here there is design, but there is no designer—an action and an object, e. doubt; but that action performing, besides what the ag intended, knew, and did, something else, (and that som thing the only important thing,) which the agent neit knew nor intended, and cannot possibly be said to ha done at all. This, by no means leads us back to De cartes's position, but does it not lead us to Sir Isa Newton's? The design is manifest; the action is perfec and surely adapted to it; the purpose is with singu regularity effected; must there not be a designer, and w can that be but the Deity? There is none other, t can be suggested, even. Must it not be HE?

A. Doubtless, in one sense, it must, as He is the D signer of all we see. But how is He more the Design here, than He is of the motions of the heavenly bodi or the growth and germination of plants?

B. As thus. In those cases, there is nothing matter affected, or acting; whatever laws were origin imposed on matter, are followed; whatever qualities fi communicated to it, are displayed: all is material. The was design in the original formation of it, in the prescri ing those laws, and impressing those qualities. That de sign, these bodies fulfil; they conform to the primev and original intention of their being. But there is no re newed design, no repeated intention, no special and pa ticular disposition, in each case of action. The Deit made a stone, and made the earth, so that the stone fal to the ground by virtue of the general rule of their form tion. He is not to be referred to; He needs not inte fere each time the support is withdrawn from the ston in order to direct the path it shall take. If on that sup port being withdrawn, some interposition were require to decide how it should go—for instance, whether it shoul stand still or not—although it be admitted, that if it move it can but move in the straight line downwards, the cas would more resemble Instinct, though even here it woul be different; for it is as if each hair's breadth of th stone's motion, required a new action to carry it on in it course.

A. The Deity created matter, so as to obey, in eac tended, being far more difficult, and more important, than the thing intended, and known to be done,) we should at once pronounce that there was a miracle, because of the thing done, being without the possibility of the apparent agent doing it unassisted, according to the ordinary laws of Nature. In other words, want of power in the immediate agent, compels us to believe in the interposition of another agent having the power. This is the foundation of all belief that there must be supernatural agency, where the laws of Nature are suspended. But in the cases put, there is not only want of power, but of design. If want of power, in the apparent agent, drives us to suppose or infer the action of another unseen agent, want of intention or design should drive us to infer the intending of another designer, and want of both power and intention should make us infer the thinking of a planner who intends, and the action of an agent able to perform the work; in other words, to infer the interference of one, who has both the will and the power, each of which is wanting in the immediate or apparent agent.

A. In the case you put, of a miracle, there is a single instance; and because it is solitary, we say the laws of Nature are suspended, and we call in supernatural aid. In the case of Instinct, it is the constant course; it would be a suspension of the law, and a miracle, were it ever otherwise. It is as much part of the law of Nature that the animal should do the thing in question, without intending it, or knowing how he does it, nay, that he does it at all, as that man should do it knowingly and intentionally, or that the animal should knowingly and intentionally do those other things, in which he acts rationally, and not instinctively. Therefore, this case does not resemble a miracle.

B. The case of a miracle, I did not put in this way, or with this view, at all. I do not say, that the instinctive acts of the animal, or of man, when he acts merely from Instinct, as he does, though most rarely, are to be compared with miracles, as being suspensions of natural law; but only, that the same reason which makes us, when arguing from such suspension of natural laws, conclude that some power has interposed, different from the powers acting under those laws, requires us, when arguing from the acts done by the animal, without either design or power, to conclude that some agent has interposed, of power sufficient, and some intending and designing being, of will fitted, to do the acts in question. Suppose, to put again my first case, with a variation, we saw a blind man draw a likeness, as often as he stretched his fingers with a pencil in them, and every foreigner of a certain class, write good English verses, as often as he tried a pen, and every man, of a particular description, make excellent timekeepers as often as he cut away the parings of the metal balls he was forming into weights,—we should, in every such instance of these general laws, (as they would now be,) have a right to draw an inference of one and the same kind. What would that be ? Manifestly, that here the same thing was done, without knowledge or intention, which in the other class of cases, (those where reason and experience operated,) was done by means of knowledge, and with intention. For the gist of the question, and the whole difficulty, is this : that we have two classes of cases—the same act done in the one class, knowingly and intentionally, and, in the other, without knowledge or intention ; and as, in the vast majority of all acts taken together of all kinds of agents, we can see no such thing—indeed, cannot form the idea of such a thing—as an act without power and will to do it, or a thing resulting to all appearance from intention, because in itself such a thing as we should do, if we intended a given thing, and yet without any Being to intend, so we are compelled to infer the power, that is, the knowledge, of the intender.

A. Indeed, it must be observed, that when we speak of a miracle, we mean, and commonly do mean, two things, not only the fact seen, of the laws of Nature being suspended, but the inference drawn of some power interposing capable of suspending them, and therefore above them, and having sway over them ; and this inference arises from the necessity under which we feel, of accounting for the phenomenon observed, by supposing an adequate cause; in short, from our being unable to conceive any thing done without a cause. The ordinary powers with which we are acquainted, fail to account for this event, and we therefore infer another power to be in operation.

B. Certainly it is so; but then this is precisely the case with Instinct, as compared with the other phenomena, namely, those things done with both knowledge and design on the part of the agent, that is, things, in doing which the agent is known to us, and intends, and knows what he does. Suppose, according to the case so well put by Paley, in the beginning of his book,—suppose you find on a common, a watch, going, and producing manifestly an effect according to its construction; this would show a design in its maker; but only a former, or bygone, a spent and executed design. Nothing would be seen designing or intending, as it were, before your eyes. Suppose, then, you saw the watch, or other machine, making a second and third machine, but not by mechanical contrivance—for that, too, like the case put by Paley, would still only be evidence of a former, or bygone, or executed design,—you must suppose a new watch to be made, before your eyes, without any material agency, or, which is the same thing, made by a machine wholly incapable of performing the operation itself. Then, you would necessarily infer, from these, the existence of some being, some thinking and designing and skilful being, capable of doing what you saw, that is, of making the machine; and you would suppose this, just as much if you saw an incapable body performing the operation, as if you saw the operation performed, without any visible, or sensible material agent at all. Now, this is precisely the case of the bee: it is the incapable body or being.

A. May it not all be said, to be only another inference of original and general design, as we deduce that conclusion from the structure of the limbs of animals, and the functions suited to that structure which those limbs perform?

B. Even if it were so, there is a broad distinction between mere mental and mere physical agency; and the difference between the inferences to which those agencies respectively lead. But I apprehend the difference is greater still than this. The two cases are not at all the same or alike, hardly even analogous. We never know of matter, or any combination of material parts, acting or affected but in one way. We have not matter with, and matter without, gravity, cohesion, impenetrability. But, if the phenomena of instinct are to be regarded as only one class of mental phenomena, we have here two kinds of mind, endowed with wholly different qualities, and acting in wholly different ways; one kind, such that the being possessed of it neither knows nor intends what he is doing, and yet all the while does exactly as if he both knew and intended. Nay, in one case, the agent, possessing this mind, is manifestly able to act; in the other, he is as clearly incompetent, in any way that we can conceive. If no being is here concerned, except the apparent, and unconscious, and impotent agent, it is like matter, gravitating to a centre which does not exist; and then to make the thing still more incomprehensible, and the difference between matter, as subject to general laws, and this case, the more extreme, both these kinds of mind are found in the same individual; for he sometimes uses, as it were, the one, sometimes the other; he sometimes acts knowingly and intentionally; sometimes blindly, as an instrument, to do he knows not what, nor cares; —as if we had a piece of matter, a lump of metal, for instance, which at one time was heavy, and at another, flew about in the air.

A. There is certainly a material difference; and I should not much wonder if we were, sooner or later, driven by the extraordinary nature of the case to some new conclusion. These things have really not been sifted, as they deserved. Men have rested satisfied with general and vague statements, and I suppose their attention has been too much engaged by the great curiosity of the facts connected with the subject, to let them closely reason upon the theory. However, I must again recur to my supposition, and refuse to quit this position, where we now stand, until we have examined it more accurately. There are two kinds of mind, I will say. Then the Deity created two kinds, originally. As He created two kinds of substance or existence, mind and matter, and as He endowed these with different qualities, so did He endow the two kinds of mind with different qualities. As He made matter solid and heavy, and made mind imperceptible to the senses, but endowed it with consciousness, so He gave the two kinds of mind different qualities—both, of course, must have consciousness, which I take to be the essence of all mind, at least, we cannot conceive mind to exist without it; but one He made such that it could act rationally, knowing and intending all it did; the other, such that it acted without knowing or intending. This hypothesis, you perceive, gets rid of the necessity of supposing a constant interposition of the Deity, unless in the sense in which He is said to interfere for the purpose of maintaining and executing the general laws which He originally framed for the whole universe.

B. I perceive no such thing. I do not think your supposition at all meets the fact, or removes the difficulty, or dispenses with the other inference. In one sense, I may grant your assumption, namely, if you only meant that the Deity originally willed the animal should act in a certain way, for a purpose which He foreordained, and which He yet concealed from the animal itself, though foreknown to Him, the Creator. But, in the same way, all rational acts and intentions may be said to have been foreknown and foreordained by the Creator, which, indeed, seems, at least in the case of an intelligent agent, only to mean, that with the Deity there is no such thing as present and future, but all things are seen as present. But then, this resolves itself into saying, that the Deity originally designed and ordered the animal's acts; and that this is the same thing as if He actually superintended and did each act of the animal at the moment of action; which is the same thing with saying, that the Deity constantly acts, and not the animal, and that is the theory in question. But, in any other sense, to what does your objection, or the hypothesis put by you in order to escape the conclusion, amount? Only to this, that the Deity created the instinctive mind such, that it acts without knowledge or intention, exactly as the rational mind acts with both the one and the other. Now the theory, of course, never meant to deny that the instinctive mind was created by the Deity, and endowed with certain qualities. Sir Isaac Newton expressly excludes the supposition of the Deity being the *anima mundi*, [soul of the world,] or the soul of any part of Nature, and clearly never intended to represent Him, as Himself the soul of animals, but only as constantly guiding that soul. But the theory holds, that the mind being endowed with certain qualities, originally, and at its creation, those qualities are summed up in this one, namely, to act, and to act *quasi* [as it were] mind, but without knowledge or design, and yet to produce all the effects of both, and, moreover, that this constitutes the whole of the qualities of instinctive mind. This mind, therefore, was created such that it must always be the blind instrument in the Creator's hands; its knowledge and design, by the hypothesis, reside as it were out of itself, and in some other intelligent being, that is, in the Deity, who is to supply, at each instant, the knowledge and design wanting in the animal mind, or to know and intend for it; and whether the Deity performs this operation, exercises knowledge and intention, beforehand, and once for all, or constantly and continually, at all times, seems an immaterial distinction referable to the former head of the alternative. The question always recurs—Was a mind created of such a species, that it could act *quasi* mind, without knowing and intending? Is not that contrary to the nature and essence of mind? Nay, is it not a contradiction in terms? And is not your whole hypothesis, of two kinds of mind, grounded on a false position, which supposes a substratum to be endowed with various qualities, and then, in order to make two kinds of that substratum, confounds the qualities with the essence? For what is mind, but that which thinks, knows, wills? If there be no knowledge, will, intention, at all, mind is not concerned in the operation, and we come to the Cartesian hypothesis, that the animal is a machine. Therefore, knowledge and design there must be; and it must either exist in the animal mind, or in some other mind which uses or employs the animal as an instrument. Can this higher mind do so, beforehand, or otherwise than by constant operation, that is, constant exertion of itself?

A. Then are we not getting either to the Deity being the soul of the animal, or to the mind of the animal having none of the qualities constituting mind?

B. We may suppose the mind to be the mere power of giving voluntary motion to the limbs, and to consist of no other quality, unless it thinks and intends. Then the Deity may have suffered it to have these powers, and to use them, in some things, and there His own intelligence does not interfere; but not to use such powers, in other things, and there His intelligence does interfere.

A. There *is* knowledge and intention in the animal. The bee, for instance, knows it is carrying wax to a given place, and placing it in a given direction. So far as the thing is done, the agent knows, and wills, and intends what it is doing, and this, in every possible case of instinctive action.

B. But the whole question arises, not upon what the bee knows and intends, for example, putting particles of wax in a place, but upon what she cannot possibly know any thing about—the giving her work a peculiar form, most difficult to discover, at first, most advantageous for a certain end, and still more difficult to follow, and work by, even when discovered. The question always is, who designs and knows these things unknown to the bee? And we cannot conceive the Deity acting thus, originally, through a future and non-existing animal; although we can easily enough imagine Him, acting through an existing animal at the time. This is supposable on the theory of essential ubiquity, or, indeed, upon any theory of ubiquity, even virtual. It merely requires ubiquity—whether of essence, or of power—some ubiquity—which no one denies, who believes in a Deity at all.

A. A child shall place together different lines and angles, or other parts of figures, so as to form certain diagrams. The figures, he thus unwittingly makes, have certain properties, quite unknown to him. All he intends or knows, is, to put the parts together; the rest is consequential, arising from the necessary relations of number, and figure: so in cases of physical or contingent truth; he may do, and mean to do, and know that he is doing, what will form a certain combination; but the laws of Nature, acting on that combination, produce, unknown to him, effects which he never intended, and knew nothing of; as, if he mixed sulphuric acid and oil of turpentine, and there was an explosion; or an acid, and an alkali, and there was a neutral salt and a crystallization.

B. This, when examined, we shall find, either to be a case wholly different from the one in question, or to be only *idem per idem*, [like unto the like,] as lawyers say when they have a case put, which is like enough to the one in hand, but just as difficult to resolve; so, in either way, the argument will remain unaffected. If the child plays with the things, at random, and they happen to fall into a certain shape once, or it may be twice, that is certainly not the case of the bee, which regularly, and without ever failing, always makes the figure required; and, upon being obstructed in her operations, varies her means, till she can again attain the particular form. If, on the other hand, the child places the things always accurately in the same way, then the case not only resembles the one in question, but becomes identical with it; all the arguments and all the difficulties apply; it is exactly *idem per idem*. So, again, if the child does a certain thing with knowledge and design to do that and no more, leaving the rest, to be done by some law of matter unknown to it,—this is not the case of Instinct; for the bee does all that is done, by the operations of mental agency; the wall, the hexagon, the rhomboid, are all made by the bee's living power; she does not place wax and leave it to fall into hexagonal forms, as we mix salts and leave them to crystallize into cubes or hexagonal prisms; she forms the figures herself, and when she has done her work, nothing remains to be done further, by any law of Nature. But if the child makes a combination constantly and correctly, say some useful substance, not to be made by accident or random working, then the case becomes the same, and the argument is not affected by it in any way.

A. You often complain of my obstinacy ; which I call sometimes caution, and sometimes slowness, according as I may be in a self-complacent or a modest humor.

B. Then, as I do not remember ever to have seen you in the former state of mind, I am sure you must always call it slowness, which no one else ever called it ; but I will call it caution, and ask what more it leads to ?

A. To this—that I would again hanker after my doctrine of general laws, primarily impressed on matter and mind both. You argue, and argue justly, that the operations of matter and of mind are to be kept apart ; you allow that the material operation is explicable by, and referable to, general laws ; you allow, too, that whatever is wrought by the operation of mind, acting as such, is explicable by, and referable to, general laws of mind, originally imposed ; *e. g.*, to desire, what is agreeable to it, by its general constitution ; to reject, what is, by the same constitution, disagreeable. But you say that we see, in the case of instinctive actions, operations, for which desires and aversions will not account, and operations carried on as if by the most refined and correct reason, and yet without any material or physical interposition ; that is, without any instrumentality whatever, as if a cast were made, without a mould, or a print without a plate. From hence, you say, it is difficult to understand how there should not be here an intelligent being, as well as mere desires connected with the senses —a cause connected with the understanding. Now, hankering as before, I still ask,—though, perhaps, after our long argumentation, with somewhat diminished confidence—may not this be accounted for, by supposing a general law adapting and adjusting all the proportions beforehand ? May not the Deity have originally appointed the taste or desire of carrying caterpillars in the solitary wasp, for instance, exactly to the very number required to feed the worm after born, when, by the laws of matter, the egg shall have been hatched and the grub produced? So may not the bee form her hexagons and her rhomboids, in consequence of a gratification felt, by a foreordained law of her nature, in following those lines and angles, and no other?

B. That this is barely conceivable, I may, perhaps, admit. But it is wholly unlike any other operation of the senses and desires, of which we have any knowledge. It means this, that each desire is so nicely adjusted, as to produce in the animal the effects of reason and intention in man, or of reason and intention in the same animal when acting with design and knowledge, and not instinctively. The bird is to have a pleasure in bringing sticks or moss to a certain place, just at a given time, and putting them in one position; the solitary wasp, in bringing, and only in bringing, for it never tastes, a certain number of caterpillars, and to have no gratification in bringing one more, but the strongest desire, because a sensible pleasure, in bringing the eleventh as much as the first; also, no kind of gratification in carrying the eleventh to any other place than the same where all the other ten were put; also, a like pleasure in forming the hole for them, without the least regard to the use she is to make of it, nay, ignorant beforehand of its being to have any use; and yet all the pleasure of carrying caterpillars is to consist in carrying them to that particular hole, and there is no gratification to be derived from carrying them to a place one hair's breadth on the right or the left. Still more—it means that the bee is to have such a gratification as proves irresistible, and occupies her whole life in tracing certain lines and angles; and yet, this strong desire is so far under control, even of reason, that on obstacles being interposed, other lines and angles are to be made, reason suspending the desire for the moment. So that the law originally imposed, and the quality impressed on the mind, was not one and inflexible, to do a certain act, in all circumstances, viz., to follow the impulse of the desires implanted, and which form the animal's nature; but it was a law or order coupled with a condition, and, as it were, giving a discretionary power provisionally, or a power to be used in certain circumstances : it was as thus ; a law or order to do a certain thing, to obey the impulse of a desire, unless certain events shall happen ; and then, and in that case, to cease following the impulse of the desire, and to follow another guide, or rather to use a faculty, namely, reason, and act according as it should direct, allow, or recommend in the circumstances. Now, in the mere union of desires with reason, while the desires act blindly, by impulse, and the reason with discrimination, there is nothing at all inconsistent or incomprehensible ; it is the ordinary case of all mental operations. But the peculiarity of the case now supposed, is, that the desires act exactly like reason, producing the very same effects, unknown to the agent, which reason does, with his knowledge. Are we not, then, calling different things by the same name, when we say that it is the influence of desires and appetites, which makes the bee form her cell, and the spider her web? Might not the same kind of argument be applied to the operations, admitted on all hands to be those of reason, for example, the investigations of Newton or Lagrange? Might it not be said, that they were influenced by an irresistible propensity, from deriving some gratification in drawing one line and using one divisor rather than another? But we know this not to be the fact. Why and how? Only from their statements and our own consciousness. But for this, the same argument might be used, and no one could refute it. So in the case of the animal, we argue thus, because we cannot ask her and learn how she works. The impulse, (it must all along be borne in mind,) of which the argument speaks, is a physical one, that is, the effect of some external object, or, which is the same thing, some operation of the animal's body, on her senses ; it is a gratification of this specific kind, which the explanation assumes—if not, it explains nothing. Then how little resemblance, does any such gratification, which we can form any idea of, (leading the bee to her lines or angles, and the solitary wasp to her carriages and deposits,) bear to what we know and feel to be the ordinary nature of physical gratification, and the desires connected with it?

A. This consideration has much weight—I mean the way you put the question as to the mathematicians. It seems to show, that we have just the same right, in the case of the animal's instinct, to conclude in favor of design and reason, and an intelligent agent, and to conclude against its being animal impulse or the direct operation of the physical senses, as we should have, did we see the mathematicians at work, observe their process, and mark the result congruous with that process, before we spoke to them on the subject of how their working was conducted. Indeed, it is remarkable, that we are, in point of fact, just as much without the evidence which the thus inquiring of them would afford, as we are in the case of the animal; for who ever asked the question, of either Newton or Lagrange, and yet who doubts that both worked their problems from knowledge, with intelligence? The reason why we do not ask them, is, that we have no kind of doubt in our minds; the view of the operation is enough for us. This is because we say to ourselves, "If I did so and so, I know it would be from knowing and meaning to do so and so, and not from any physical gratification." This inference, we transfer to others, by saying, "Therefore I believe they act in like manner."

B. Certainly: and this, observe well, is the foundation of all our reasoning as to design. The only argument we ever have, or can have, in favor of any intelligent cause, from seeing the adaptation of means to ends, on surveying the works of Nature, is, that, if we had done so and so, we should have had the design. All we see, is the fact of an adaptation; the inference of a cause, or of a designing being, rests on the kind of reasoning you have just stated. So that, in reality, we have reached this important position, that our argument for the existence of a designing cause at all, in the universe, rests on no better, indeed on no other, foundation, than our argument that instinctive action proves an interposition of the Deity at each moment.

A. I must further observe, however, that besides the great weight of this consideration, as last presented, I feel the difficulty of the hypothesis of an original law, generally imposed, to be much aggravated by the consideration you adverted to, at the same time, of a provisional and conditional law—a law to operate, or not, according to circumstances, as if two implements had been given to the animal, Instinct and Reason; for I feel the very gratuitous nature of this assumption; and I know that there is not a greater proof of our reasoning being merely hypothetical, on any question, than when we find ourselves obliged to mould, refit, and modify our hypothesis, in order that we may adapt it to the new observations of fact.

B. But there remains a difficulty, still more insuperable, in your way, which you do not yet advert to. The supposition of a law, and a provisional or conditional law, is all along founded on the assumption of a person to obey it, to act instinctively, unless a certain thing happens, and then to use Reason till a certain other thing happens, and then to fall back upon Instinct again. What can be more gratuitous, not to say absurd? The supposition that the Instinct is to cease, and the Reason to begin, in a certain event, implies, that the animal, acting by Instinct, all the while was reasonable and intelligent, else how could he know when to lay down his Instinct, and take up his Reason? If I send a man to go straight on, till he meets a messenger, or sees a finger-post, he is just as much a rational agent, all the while he does not deviate from the way, as he is, when, meeting the messenger or seeing the guide-post, he does deviate. So that the theory involves here this absurdity, that the instinctive action is all the while an intelligent and rational operation, contrary to the supposition. I can really imagine nothing more decisive or demonstrative than this; and I purposely kept it to the last.

A. Perhaps the end is not yet come; you have said nothing of the known errors or mistakes of instinct; and thus I reserve also my strongest argument to the last. I own that it was this consideration, which, always meeting me, drove me to deny the Newtonian doctrine, and to find any or every other escape from it; for surely, if the

Deity is always acting, there can be no mistake—every thing must be perfectly successful and quite certain. Yet how many cases of mistaken instinct do we see? Mules begotten; flies deceived by the smell of the stapelia* to lay their eggs where they cannot breed the maggots, supposing the vegetable an animal substance putrefying; and many others. Now, if this was only the result of similar desires, originally implanted, there is no difficulty; for the law would be to follow that smell, and this law is obeyed.

B. Now, I really think you have just yourself answered your strongest argument; for you admit there was that general law. Had it no design? Doubtless, and but one, to lead the animal towards its food, and the nest for its young—the two great objects of all Nature, preserving the individual, and continuing the species. Yet here they fail in particular instances, and do neither. Then is not this a defect or imperfection in the general law, detracting, *pro tanto*, [for its value,] from its adaptation, to work its undoubted purpose? The same Being gave the general law, whom the Newtonian theory supposes to be the particular agent. Then is it not just as inconsistent with His perfections, to believe He has made a faulty statute, as to suppose that He makes a mistake in particular cases? Can there be any difference at all, here?

A. How do we get out of this, in the general case?

B. You mean, how do we answer skeptical, or rather atheistical arguments, drawn from these supposed errors or imperfections? Only by saying, that as in the great majority of cases, the design is perfect, and the wisdom complete, it is probable that further knowledge would remove all apparent anomalies, and reduce every thing to order, and to a consistency with perfect wisdom and skill. In truth, we always assume design, even where we cannot trace it. The physiologist never supposes any part which he sees produced, as the spleen, to have no use; but rests satisfied that there is a purpose, though he has failed to discover it; and he hopes that it will hereafter be revealed to his inquiring eye. So, when he finds apparent imperfection, he has a right, nay, it is sound logical reasoning, to suppose, that further knowledge would prove it to be perfect, as, in the vast bulk of cases, he has found perfection. The instances of erroneous or defective instinct, are as mere nothing, compared to those of true or perfect instinct.

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* [A genus of African plants, so named by Linnæus in honor of Dr. Stap ', of *Amsterdam, the* learned editor of the works of Theophrastus.]

A. We also approach, here, the argument on the Origin of Evil. There is something to be said, though perhaps not much, as to the irreverent nature of the supposition, that the Deity acts, considering the meanness or impurity of some instinctive operations, and the trifling nature of others.

B. You may well say, not much in this; there is absolutely nothing at all. Our present argument, only refers to physical and not to moral considerations. Moral feelings or actions are, of course, not instinctive at all. There is no blame where there is no choice—no knowledge—no intention—no reason. Then, as to indifferent acts; there is nothing small, or mean, or impure in the Deity's eye. There is nothing in this, more than is sometimes, without due consideration, urged against the doctrine of Essential Ubiquity. It all proceeds upon a forgetfulness that the Deity cares as much for one creature as another; all are alike proofs of His wisdom; all alike objects of His favor. So as to matter; there is nothing impure or disgusting, except in relation to our weak and imperfect senses, which are, for wise purposes, so formed, as to delight in some things, and to repudiate others. This is all relative, and relative to ourselves and our imperfect nature. To the Deity it can have no application. The structure and functions of the maggot, bred in the most filthy corruption that can disgust our senses, exhibits, even to the eye of the philosopher, how cumbered soever with the mortal coil, as marvellous a spectacle of Divine skill and benevolence, as the sanguiferous or the nervous system of the human body, or the form of the most lovely and fragrant flower that blows.

A. I think the instinct of hunger has begun to operate upon my structure, whether stimulated by the operation of the gastric juice upon the coats of the stomach, or how otherwise, I do not stop to inquire. Nor do I apprehend that our good hostess's instinctive love of order and method would approve of our keeping dinner waiting.

B. Your own excellent mother was the pattern of that regularity, as of so many other admirable qualities; and the intercourse of society was in this, as in far more important particulars, greatly reformed by her example. Therefore, let us adjourn our further discussion, of which not much remains, till to-morrow, at least not much that is difficult.

BOOK, OR DIALOGUE III. ANIMAL INTELLIGENCE.—(FACTS.)

A. It must be confessed, that for a subject so extremely amusing, as well as interesting in a higher view, Instinct has been giving us but little matter of entertainment. I question if any persons ever talked upon it, for so many hours, without almost a single anecdote, or illustration of any kind from the facts, which are inexhaustible in variety, and every hour present new matter of wonder. Indeed, those ordinarily known, are full of interest; and we have been going on, with, I think, two, the bee and the solitary wasp, never even casting a look over the rest of this boundless and variegated field.

B. Why, truly so; and the reason is plain enough. We had a problem to solve, and we set ourselves to try our hand at it. We assumed that the whole facts resembled those few to which we applied our arguments, or from which we drew our inferences; and our choosing two was quite right and safe—indeed, one rather than two, for we have dwelt more on the solitary wasp than even the bee, because no question could ever be made in her case of training or traditionary instruction. I do not at all repent of having pursued this course; it has prevented digressions and distractions, which would have ensued, had we gone upon the facts at large. We should have been perplexed, sometimes by questions of evidence, sometimes by minute differences, of no importance to the argument, sometimes by analogies only calculated to mislead. Our way has been to pitch upon a good example or two, which in some sort embody the subject, as far as matter of fact is concerned—an abstraction of Instinct, as it were, without immaterial particulars—and to confine our reasonings and our illustrations to that. However, there can be no sort of reason, why we should not now reward ourselves with a little of the entertainment, which, as you say, so amply belongs to this great subject.

A. The Instincts, which we have been considering as our choice examples, especially that of the bee, are certainly the most wonderful of all the animal phenomena. But the cases where sagacity is shown, and which seem really quite inconsistent with the doctrine that denies brutes all rational faculties, are most frequently cited to raise men's wonder; and, as I take it, for this reason, that we set out with supposing the common animals to be wholly devoid of intelligence, and are astonished to find them sometimes acting as if they had it—while the operations of Instinct being in many brutes above what any degree of intellect can account for, we refer these to a totally different origin.

B. I quite agree with you. Perhaps one need not go much more now into examples of Instinct. None can exceed that of the bee, which has, from the beginning of the creation, been working, and all over the world working, in the same manner, upon the successful solution of a problem in the higher mathematics, which only the discovery of the differential calculus a century and a half ago could enable any one to solve without great difficulty at all; and which a celebrated mathematician, who was devoted to the ancient geometry, though an adept also in modern analysis, when he solved, conceived that he had gained no small victory for that favorite science by showing that it could solve this question of maxima and minima.

A. Nevertheless, there are other wonders, of a like kind, those which show Instinct to be as great in manufactures, as the honeycomb proves it to excel in architecture. The papermaking of the wasp is of this class. She makes a paper as excellent as any manufacturer; she has been, for sixty centuries, acquainted with what was only discovered, by men, between five and six centuries ago;—for I think the question raised by Meerman, confined the discovery to the years between 1270 and 1302, though afterwards a specimen was produced as early as 1243. Moreover, when some of the more recent improvements, as the lengthening and equalizing the fibres, are considered, it is found that the wasp was all along acquainted with these useful devices also.

B. I have observed, too, in examining her structures, that she makes two kinds of paper, white and brown, the former being fine cambric paper, and the two glued together, by an excellent smooth and durable kind of cement. The white paper, I find, takes the ink as well as if it were sized.

A. When stories are told to excite wonder under the head of Instinct, they generally relate not to Instinct, but to the Reason or Intelligence which animals show. However, there are other wonders of Instinct, beside those we have been adverting to. The uniformity of the operations of animals of the same species, every where and at all times, is remarkable; and the expertness they show, from the first, clearly proves that instruction and experience have nothing at all to do with the matter. Bring up a crow, under a hen, or under any other bird, it makes as exact a crow's nest, as if it were born and bred in a rookery.

B. So Maraldi found, that a bee, an hour old, flew off to the proper flowers, and returned in a little time with two pellets of farina, then supposed to be the material for making wax, now known to be used only in making bees' bread, since the capital discovery of our John Hunter showed wax to be, like honey, a secretion of the animal. Nay, before birth, too, the animal works to an end, and with the same exact uniformity. The inimitable observations of the great Reaumur show, that the chick, in order to break the egg-shell, moves round, chipping with its billscale, till it has cut off a segment from the shell. It always moves from right to left; and it always cuts off the segment from the big en There is no such thing, as a party of what Gulliver ca "little-endians," in Nature. All these singular Instinct however, regular and uniform though they be, are, wh circumstances require it, interfered with, by the ration process of adapting the means to the end, and varyi those means where the end cannot otherwise be attaine But Instinct, is regular and steady in all ordinary circu stances.

A. The vast extent of the works performed by anima especially by insects, is no less wonderful, than their in stinctive skill. This arises from their immense number and the singular Instinct whereby they always work i concert, when gregarious. What can be more aston ing, than the work of the termites or white ants, which in a night, will undermine and eat out into hollow galleries, a solid bed or table, leaving only the outside shell or rind, and soon will make that, too, disappear!

B. Or the ant-hills in tropical countries, twelve and fifteen feet high, as if men were to make a building the height of the Andes or Himmaleh Mountains, when they are vain of having made the little pyramids? But let us go to instances of the other class—of Intelligence.

A. Had we better begin this new discussion, by ascertaining whether or not the doctrine of a specific difference between man and the lower animals is well founded; or had we better begin with the facts?

B. I am, upon the whole, for beginning with the facts; and I should come at once, as we have just been speaking of concerted operations of Instinct, to the case of the beaver, which is, under the head of Intelligence, almost as wonderful, as the proceedings of the bee and the ant are under that of Instinct.

A. But before quitting the bee, and the ant, and the wasp, let us just observe their rational acts. They are nearly as notable as their instinctive ones. The bee, upon being interrupted by Huber in her operations, shortened the length of her cells; diminished their diameter; gradually made them pass through a transition from one state to another, as if she was making the instinctive process subservient to the rational; and, in fine, adapted her building to the novel circumstances imposed upon her; making it, in relation to these, what it would have been in relation to the original circumstances, if they had continued unaltered. It is found, too, that the ant, beside the wonderful works which she instinctively performs, has the cunning to keep aphides,* which she nourishes for the sake of obtaining from them the honey-dew forming her favorite food, as men keep cows for their milk, or bees for their honey.

B. On this discovery of Huber some doubt has lately been thrown; and do not let us trouble ourselves with anything at all apocryphal, when the great body of the text is so ample and so pure. But the expeditions of a predatory nature, are by all admitted. Ants undertake expeditions for the purpose of seizing and carrying off slaves, whom they afterwards hold in subjection to do their work.

A. But the wasp, too, shows no little sagacity, as well as strength. Dr. Darwin relates an incident, to which he was an eyewitness, of a wasp having caught a fly almost of her own size; she cut off its head and tail, and tried to fly away with the body, but finding that, owing to a breeze then blowing, the fly's wings were an impediment to her own flight, and turned her round in the air, she came to the ground, and cut off the fly's wings, one after the other, with her mouth. She then flew away with the body unmolested by the wind.†

B. I have myself observed many instances of similar fertility of resource in bees. But perhaps the old anecdote of the Jackdaw is as good as any—who, when he found his beak could not reach the water he wanted to drink, threw into the pitcher pebble after pebble, till he raised the surface of the liquid to the level of his beak. Lord Bacon tells it of a Raven, filling up the hollows in a tree where water had settled.

A. Or the Crows of whom Darwin speaks, in the north of Ireland, who rise in the air with limpets and muscles, to let them fall on the rocks, and break them, that they may come at the fish. It is said that animals never use tools, and Franklin has defined man a tool-making animal; but this is as nearly using tools as may be; at least, it shows the same fertility of resources, the using means towards an end.

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* *[Vine fretters or plant lice.]*

† Zoonomia, sec. xvi. 16.

B. It does a little more. It shows the highest reach of ingenuity, the using the simplest means to gain your end—the very peculiarity for which Franklin's own genius was so remarkable. He could make an experiment with less apparatus, and conduct his experimental inquiry to a discovery with more ordinary materials, than any other philosopher we ever saw. With an old key, a silk thread, some sealing-wax, and a sheet of paper, he discovered the identity of lightning and electricity. Here we are instituting a harmless comparison, between the bird and the sage: but the crow's genius is said once to have come in collision with the head of a philosopher, in a less agreeable manner, when, mistaking the bald scull of Anaxagoras for a rock, she let fall the oyster from such a height, that it killed him.

A. But there certainly must be allowed to be even nearer approaches to tool-making, or at least, to the use of tools, among animals. There are many insects which use hollow places, and some which use hollow reeds or stalks for their habitations.

B. Indeed they do; and perhaps the most remarkable, of all proofs of animal intelligence, is to be found in the nymphæ of water moths, which get into straws, and adjust the weight of their case so that it can always float;—at least, Mr. Smellie says, that, when too heavy, they add a piece of straw or wood, and when too light, a bit of gravel.* If this be true, it is impossible to deny great intelligence to this insect.

A. Why should we doubt it? The crow in rising, and letting the mussel fall, shows as great knowledge of gravitation, as the moth in this case.

B. But an old monkey, at Exeter Change, having lost his teeth, used, when nuts were given him, to take a stone in his paw and break them with it. This was a thing, seen forty years ago, by all who frequented Exeter Change, and Darwin relates it, in his Zoonomia. But I must say, that he would have shown himself to be more of a philosopher, had he asked the showman, how the monkey learned this expedient. It is very possible he may have been taught it, as apes have oftentimes been taught human habits. Buffon, the great adversary of brute intelligence, allows, that he had known an ape who dressed himself in clothes, to which he had become habituated, and slept in a bed, pulling up the sheets and blankets, to cover him before going to sleep ; and he mentions another which sat at table, drank wine out of a glass, used a knife and fork, and wiped them on a table napkin. All these things, of course, were the consequence of training, and showed no more sagacity than the feats of dancing-dogs and bears, or of the learned pig ; unless it were proved, that the ape, on being taught these manipulations, became sensible of their convenience, and voluntarily, and by preference, practised them—a position which no experiments appear to support. Smellie, however, mentions a cat, which, being confined in a room, in order to get out and meet its mate of the other sex, learnt of itself to open the latch of a door ; and I knew a pony in the stable here, that used both to lift the latch of the stable, and raise the lid of the corn-chest—things which must have been learnt by himself, from his own observation, for no one is likely to have taught them to him. Nay, it was only the other day, that I observed one of the horses, taken in here to grass, in a field through which the avenue runs, open one of the wickets, by pressing down the upright bar of the latch, and open it exactly as you or I do.

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* Transactions of the Royal Society of Edinburgh, vol. i., p. 42.

A. I have known, as most people living in the country have, similar instances, and especially in dogs.

B. But there is one instance of animals catching their prey, in a way still more like the tool-making animal. I do not allude merely to the spider's web, or to the pelican's use of his large open pouch in fishing ; but to an American bird, of which you find a curious account in the

*Philadelphia Transactions.** It is called the ***neun-tödter*** by the Germans, as we should say, the ***nine-killer***, and is found to catch grasshoppers and spear them when dead upon twigs, where the small birds come,on which it feeds; for the grasshoppers, themselves, it never touches. These are left, generally about nine in number, (whence its name,) the whole winter, and they attract the birds, of which the animal in question makes its prey. This is really using one creature as a bait, in order, thereby, to decoy and catch another.

A. It is certainly a singular and curious instance, whether of Instinct or Intelligence. Are there not stories told, of apes using a cat or some other animal—I should suppose rather any thing than a cat—to get chestnuts out of the fire?—or what else is the origin of the phrase ***cat's paw***?

B. Fable, I presume. Many fables have a real origin, in fact: this, I suspect, has not. Monkeys, on the contrary, have been used by men to obtain fruit or cocoanuts, by pelting them, and their defending themselves with a fire of nuts.

A. That, however, is a plain instance of sagacity and imitation. They used missiles, as missiles were used against them. Some of our own belligerent measures of retaliation, have not always been nearly so judiciously contrived.

B. No: we once, by way of retaliating on Napoleon, helped him; as if the monkeys had pelted themselves, instead of throwing at us. However, an unexceptionable authority, Captain Cook, or at least Captain King, in Cook's last voyage, has a singular instance of sagacity in the use of means, and almost weapons, in Bears. Here you have his account of their mode of hunting: "The wild deer, (*barein*,) are far too swift for those lumbering sportsmen; so the bear perceives them at a distance by the scent; and, as they herd in low grounds, when he approaches them, he gets upon the adjoining eminence, whence he rolls down pieces of rock; nor does he quit his ambush, and pursue, until he finds that some have been maimed."†

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* Vol. iv.

† Cook's Third Voyage, vol. iii., p. 306.

A. Certainly, such a well-attested fact as this, is very important, and worth a thousand stories of lions and jackals. But you spoke of coming at once to the beaver, as the parallel to the bee.

B. Certainly it is, and may be called, in respect of its works, the bee of quadrupeds, or, if you will, of Intelligent animals, holding among them as high a place as does the bee among Instinctive creatures. Nevertheless, there may be some doubt raised, how far Instinct has a share in his operations. They are of great uniformity; all packs or companions of beavers, and at all times, build the same-shaped structure, and resemble one another closely in matters which are arbitrary, and therefore cannot be considered as the result of experience or reflection—cannot be dictated by circumstances. This, however, opens a question of some difficulty, which, according to the plan we are pursuing, may be left to the end of our discussion, after we shall have gone through the facts. In considering the beaver, I think we shall do well to follow Buffon, as we did upon the ape, because he purposely rejected every thing marvellous or doubtful, in the accounts he had received from travellers, and these must have been numerous, for Canada was then a French colony. Those singular animals assemble in bodies of two to four hundred, and choose a convenient station in the lake or the river, having regard to the slope of its banks and their woodiness, but also, no doubt, to the frequency of floods in the water. If it is a lake, or a river that varies little in its level, they build their huts without any further structure; but if the level changes much, they construct a dam or dike, what we call a breakwater, extending eighty or one hundred feet across, and ten or twelve broad; they thus keep the water nearly of the same height, at least they thus always obtain a sufficient depth of water. They then work in concert on the wood, gnawing the trees and branches to suit their operations. A tree, the thickness of a man's body, they will soon bring down by gnawing round its base; and they know so exactly the operation of gravity on it, that they make it fall always across the stream, so as to require no land carriage. It must be observed, in passing, that if they do this the first time they have built, and without any previous experience of falling bodies, the operation must be taken as purely instinctive. They form their cabins, so as to contain from fifteen to twenty-five or thirty animals; each cabin has two doors, one to the land, and one to the water, in order that they may either go ashore, or bathe or swim, and sit in the water, which is part of their pleasure, or rather of their amphibious existence. They have in each cabin, also, a storehouse, for placing the parts of the shoots on which they feed, (for that they make provision against winter is quite certain,) and room enough for accommodating their young when brought forth. The cabins are built so as to be out of the water; they are neatly plastered with cement, the animal's flat and scaly tail being used as a trowel in this operation. They are of sufficient strength to resist, not only the stream and floods to which occasionally they may be exposed, but also severe storms of wind. The beavers choose to work with a kind of earth not soluble in water, and which they mix with clay. Such is the account of those very rational and intelligent proceedings, which Buffon, skeptical beyond all men of stories respecting animal reason, sifted out of all he had heard, after rejecting every thing that bore the appearance of exaggeration or fancy. He adds, that a single beaver which he had, showed, in its solitary and domestic state, no signs of sagacity or resources; but rather appeared to be a stupid animal. According to his strange theory, that animals are degenerating in mind, and losing their faculties, as man improves, (a notion derived from confounding their loss of dominion, power, and numbers, in a wild state, with their loss of intellect,) he considers the beaver as the "only subsisting monument of the ancient intelligence of brutes."

A. They say doubts have of late been cast upon the former accounts of the beaver. I am told, Hearne, one of the best North American travellers, is cited for this.

B. Here is what that excellent observer says upon the subject; you shall judge if he has in the least altered the case. The beavers select, he says, either in small lakes or in rivers, spots where the water is of such depths as not to freeze to the bottom, preferring, however, running water, because this helps them to convey the timber they require. They begin by forming a dike across with fascines, stones, and mud, but without piles buried in the ground; this dike, whose only use is to give them a convenient level of water, is convex on the upper side, fronting the stream; and it becomes solid and strong by repeated repairs, so that the branches sprout, and birds build in the hedge which it forms. Each hut contains commonly one or two, but sometimes four, families; and sometimes each is separated from the others, by a partition. The hut has a door opening on the water, and no connexion with the land. He then goes on to show how they cut down and build, wherein he differs from the common accounts, only in saying, that no piles are used in the construction. They work, he says, only by night, and each season they cover the buildings with a new coat of mud-plaster, as soon as the frost sets in. In summer, they make excursions in the woods, choosing the trees they mean to make use of, and marking the position of new settlements, when their increase of numbers requires them to plant colonies. Their wood-cutting begins at the end of summer, and the building is carried on in autumn. They have also subterraneous retreats, along the banks of the river or lake, to serve as a place of refuge, when they may be attacked by the glutton. You perceive, then, that there is very little discrepancy between this account and Buffon's; indeed, there is one remarkable addition to the latter, if it can be relied upon, the precaution taken in summer, to choose and to mark out the convenient stations where the new settlements are afterwards to be made.

A. There seems reason to suppose that other animals still preserve their sagacity, and act in concert. No one can have observed a flock of pigeons, without perceiving that they have sentinels posted to give the alarm. Indeed, wilder birds act in like manner. Fieldfares, when they are occupying a tree which you approach, remain steady and fearless until one at the extremity rises on her wings and gives a loud and very peculiar note of alarm, when they all get up and fly, except one who continues till you get near, as if she remained to see that there really was occasion for the movement, and to call them back, if the alarm proved a false one. She, too, at length flies off, repeating the alarm-note.

B. In the forests of Tartary and of South America, where the Wild Horse is gregarious, there are herds of five or six hundred, which, being ill prepared for fighting, or indeed for any resistance, and knowing that their safety is in flight, when they sleep, appoint one, in rotation, who acts as sentinel, while the rest are asleep. If a man approaches, the sentinel walks towards him as if to reconnoiter or see whether he may be deterred from coming near; if the man continues to advance, he neighs aloud, and in a peculiar tone, which rouses the herd, and all gallop away, the sentinel bringing up the rear. Nothing can be more judicious or rational than this arrangement, simple as it is. So a horse, belonging to a smuggler at Dover, used to be laden with run spirits, and sent on the road, unattended, to reach the rendezvous. When he descried a soldier, he would jump off the highway, and hide himself in a ditch, and when discovered would fight for his load. The cunning of foxes is proverbial; but I know not if it was ever more remarkably displayed than in the Duke of Beaufort's country; where Reynard, being hard pressed, disappeared suddenly, and was, after strict search, found immersed in a water-pool up to the very snout, by which he held a willow-bough hanging over the pond. The cunning of a dog, which Sergeant Wilde tells me of, as known to him, is at least equal. He used to be tied up as a precaution against hunting sheep. At night, he slipped his head out of the collar, and returning before dawn, put on the collar, again, in order to conceal his nocturnal excursion. Nobody has more familiarity with various animals, (besides his great knowledge of his own species,) than my excellent, learned, and ingenious friend, the Sergeant; and he possesses many curious ones himself. His anecdote of a drover's dog, is striking, as he gave it me, when we happened, near this place, to meet a drove. The man had brought seventeen out of twenty oxen from a field, leaving the remaining three there mixed with another herd. He then said to the dog, "Go fetch them;" and he went and singled out those very three. The Sergeant's brother, however, a highly respectable man, lately Sheriff of London, has a dog, that distinguishes Saturday night, from the practice of tying him up, for the Sunday, which he dislikes. He will escape, on Saturday night, and return on Monday morning. The Sergeant, himself, had a gander, which was at a distance from the goose, and hearing her make an extraordinary noise, ran back and put his head into the cage, then brought back all the goslings one by one and put them into it, with the mother, whose separation from her brood had occasioned her clamor. He then returned to the place whence her cries had called him. I must, however, add, that I often have conversed with Scotch shepherds coming up from the Border country to our great fairs, and have found them deny many of the stories of the miraculous feats of sheep-dogs. Alfred Montgomery and I, the other day, cross-questioned a Roxburghshire shepherd, with this result.

A. Many of the feats, which we are now ascribing to intellectual faculties, may be instinctive operations. How shall we distinguish?

B. The rule seems simple. Where the act is done in ordinary and natural circumstances, it may be called instinctive or not, according as it is what our reason could, in the like circumstances, enable us to perform or not, and according as the animal is in a situation which enables him to act knowingly or not. Thus, a bee's cell is made by a creature untaught; a solitary wasp provides food for an offspring it never can see, and knows nothing of. We set these things down to Instinct. If horses, fearing danger, appoint a sentinel, it may be Instinct, certainly, but there is here nothing to exclude Intelligence, for they do a thing which they may well do by design, and so differ from the bee; they are aware of the object in view, and mean to attain it, and so differ from the wasp. But these remarks apply to acts done in ordinary circumstances, and which I admit may or may not be instinctive. Another class is clearly rather to be called rational. I mean, where the means are varied, adapted, and adjusted to a varying object, or where the animal acts in artificial circumstances in any way. For example, the horse, opening a stable-door; the cat, a room-door; the daw, filling a pitcher with stones. So there is a singular story, told by Dupont de Nemours, in Autun's *Animaux Célèbres*, and which he says he witnessed himself. A swallow had slipped its foot into the noose of a cord attached to a spout in the College des Quatre Nations at Paris, and by endeavoring to escape, had drawn the knot tight. Its strength being exhausted, in vain attempts to fly, it uttered piteous cries, which assembled a vast flock of other swallows from the large basin between the Tuilleries and Pont Neuf. They seemed to crowd and consult together for a little while, and then one of them darted at the string and struck at it with his beak, as he flew past; and others following, in quick succession, did the same, striking at the same part, till after continuing this combined operation, for half an hour, they succeeded in severing the cord, and freeing their companion. They all continued flocking and hovering till night; only, instead of the tumult and agitation in which they had been, at their first assembling, they were chattering, as if without any anxiety at all, but conscious of having succeeded.

A. The means taken to escape from danger, and to provide for security, are certainly often of this description, the danger being often of a kind purely accidental and solitary, and the operation of the animal varying in different and new circumstances. Some birds wholly change their mode of building, to avoid snakes, hanging their nests to the end of branches, and making the exit in the bottom, in places where those reptiles abound.

B. So too, the ants in Siam make no nests on the ground, as with us, but on trees, that country being much subject to inundations. But you find this change of habits, in animals, upon circumstances changing, pretty general. The dogs, which the Spaniards left in the island of Juan Fernandez, were found to have lost the habit of barking, when Juan and D'Ulloa visited that famous spot in the course of their journey in South-America. Possibly, they found that barking warned their prey, and enabled it to escape. But dogs, in Guinea, howl and do not bark, and when European dogs are taken there, they lose their bark in three or four generations. This fact, then, is somewhat equivocal.

A. The docility of some animals, may, however, as it seems to me, be strictly ranged within the class of facts we are speaking of. Although children, as well as animals, learn through fear and kindness, both operating, (and fear alone would suffice,) yet it is an act of Intelligence to follow the dictates of both feelings : it implies this process of reasoning,—" If I do so and so, I shall have such a punishment, or such a reward." Now, the degree to which animals are teachable, is wonderful. All singing-birds probably learn their whole notes.

B. Yes ; Daines Barrington has demonstrated this, by numerous experiments,* on various birds ; the young untaught bird, being placed in the nests of different species of birds, always had the song of those it nestled with ; and we all know how a piping bullfinch can be taught almost any tune. They seem to have no notion of harmony or melody. I recollect a green linnet, which I had, when a boy, or rather a mongrel between that and a goldfinch, being placed in a kitchen, and leaving its own fine and sweet notes, to take to an imitation, and a very good and exceedingly discordant one, of a jack, which, being ill-constructed, generally squeaked as if it wanted oiling.

A. Dogs show the greatest talents in learning. The feats of pointers, but still more of shepherds' dogs, after making all the deductions you have mentioned, are astonishing. It almost seems as if the shepherd could communicate, by sign or by speech, his meaning, when he desires to have a particular thing done. But assuredly the dog takes his precautions exactly as he ought to prevent the sheep from scattering, and to bring back runaways. Indeed, greyhounds and other dogs of chase, as well as pointers backing one another, show the adaptation of, and variation in, the means used towards an end.

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* Phil. Trans., 1776.

B. Retrievers exceed all other dogs, in this respect. There was one died here, a year or two ago, that could be left to watch game, till the keeper went to a given place, and she would then join him, after he had ranged the field ; nay, could be sent to a spot where game had been left, and where she had not been before. Indeed, she did many other things, which I have hardly courage to relate.

A. How were her pups ? I have always found such extraordinary faculties hereditary.

B. My worthy, intelligent, and lamented friend, T. A. Knight, (so long president of the Horticultural Society,) has proved, very clearly, that the faculties of animals are hereditary to such a point as this. He shows that even their acquired faculties—the expertness they gain by teaching—descends in the race. His paper is exceedingly curious. But I think we need hardly go so far as to his minute details, for proof of the fact. It is found, that where man has not been, no animals are wild and run away from his approach. When Bougainville went to the Falkland Islands, (or, as the French call them, the Malouines,) he found himself and his men immediately surrounded by all kinds of beasts and birds, the latter settling on their shoulders. No navigators had ever been there, before. Lord Monboddo says, that the same thing had been related to him by navigators.* It seems clear, then, that the running away from man, which seems natural to all wild animals in, or bordering upon, inhabited countries, is an acquired propensity, transmitted to the descendants of those whose experience first taught it them as necessary for their safety.

A. Have you Knight's paper, here ? I know the accuracy of his observation, to equal his great ingenuity.

B. To that, I, too, can bear my testimony. Here, is his principal paper, read lately before the Royal Society. It is given as the result of his observations and experiments, made for a period of sixty years ; it is therefore most justly entitled to great respect. He chiefly dwells on the case of springing spaniels, and among other instances gives this, which is indeed very remarkable. He found the young and untaught ones as skilful as the old ones, not only in finding and raising the woodcocks, but in knowing the exact degree of frost which will drive those birds to springs and rills of unfrozen water. He gives the instance, too, of a young retriever, bred from a clever and thoroughly-taught parent, which, being taken out, at ten months old, with hardly any instruction at all, behaved as well and knowingly as the best taught spaniel, in rushing into the water for game that was shot, when pointed out to it, however small; bringing it, and depositing it, and then going again, and when none remained, seeking the sportsman and keeping by him. He imported some Norwegian ponies, mares, and had a breed from them. It was found that the produce "had no mouth," as the trainers say; and it was impossible to give it them; but they were otherwise perfectly docile. Now in Norway, draught horses, as I know, having travelled there and driven them, are all trained to go by the voice, and have no mouth. Again, he observed that they could not be kept between hedges, but walked deliberately through them, there being, he supposes, none in the country from which their dams came.

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* Origin of Language, B. II., Ch. 2.

A. Does he speak of any other animal?

B. Yes, he mentions his observation on woodcocks, which he could remember having been far less wild half a century ago; for on its first arrival in autumn, it was tame and chuckled about if disturbed, making but a very short flight, whereas now, and for many years past, it is very wild, running in silence, and flying far. He gives an instance of sagacity in a dog, unconnected with hereditary intelligence. He one day had gone out with his gun and a servant, but no dog. Seeing a cock, he sent the servant, who brought the spaniel. A month afterwards, he again sent for the same dog from the same place. The servant was bringing him, when at twenty yards from the house, the spaniel left him, and ran away to the spot, though it was above a mile distant. This he often repeated and always with the same result; as if the animal knew what he was wanted for. Leonard Edmunds tells me of a dog, (a Newfoundland spaniel,) of Mr. Morritt's, at Rokeby, which has been known to take the shorter road to where he knew he was wanted, and leave the servant or keeper to go round about. You, yourself, told me of a dog, that met you, sporting, by a short cut, unknown to you.

A. The manner in which animals can find their way is very extraordinary. But though, in many cases, it may be through close observation, and observation the clearer and better remembered because, like the Indian woodsmen, they have so few ideas; yet, in other cases, it seems an Instinct very difficult to conceive in its workings. In truth, if the stories told be true, I question if any instance we have yet examined, of Instinct, be so truly unaccountable, on any principles of intelligence. I have known of dogs sent to a distance, and coming home immediately, though taken in the dark.

B. That might be from smell or track; but stories are also told of dogs and cats taken in hampers, and finding their way back speedily. L. Edmunds had one, that was carried from Ambleside, to three miles on the other side of Burton, a distance of twenty-seven miles, in a close hamper, by a coach; and it found its way back next morning. Dr. Beattie's account of a dog, which was carried in a basket thirty miles distance, through a country he never had seen, and returned home in a week, is less singular than this, even if it were as well authenticated. Dr. Hancock, in his excellent work on Instinct, which, however, contains fully as much upon the peculiar tenets of the Society of Friends as upon our subject, relates the story of a dog being conveyed from Scotland to London, by sea, and finding his way back; of a sheep, returning from Yorkshire to Annandale, a distance of at least eighty miles; and of another sheep returning from Perthshire to the neighborhood of Edinburgh. Kirby and Spence, too, in their *Introduction to Entomology*, state, on the authority of a captain in the navy, a strange anecdote of an ass taken from Gibraltar to Cape de Gat on board of a ship, and finding its way immediately back, through Spain, to the garrison, a distance of two hundred miles of very difficult country. The ass had swam on shore when the ship was stranded. This fact seems to be well-authenticated, for all the names are given, and the dates.

A. There is no end of such facts, and many of them seem sufficiently vouched. The *Letters on Instinct* mention a cat, which had been taken to the West Indies, and on the ship returning to the Port of London, she found her way through the city to Brompton, whence she had been brought.

B. That is a work I have often wished to see and never been able to get. Dr. Hancock quotes it for one of the most remarkable proofs of sagacity and resource in the goat, and this operation has been, it seems, observed more than once. When two goats meet, on a ledge bordering upon a precipice, and find there is no room, either to pass each other, or to return, after a pause, as if for reflection, one crouches down and the other walks gently over his back, when each continues his perilous journey, along the narrow path.

A. In Rees's Cyclopedia, a story is given as well vouched, of a cat, that had been brought up in amity with a bird, and being one day observed to seize suddenly hold of the latter, which happened to be perched out of its cage, on examination, it was found that a stray cat had got into the room, and that this alarming step was a manœuvre to save the bird, till the intruder should depart. But what do you make of carrier-pigeons ? The facts are perhaps not well ascertained ; there being a good deal of mystery and other quackery about the training of them.

B. I desired one of the trainers, (they are Spitalfields weavers, generally,) to come, that I might examine him about his art, but he has never been with me. I have read and considered a report made to me on the subject. It is said, the bird begins his flight by making circles, which increase more and more in diameter as he rises ; and that he thus pilots himself towards his ground. But still, this indicates an extraordinary power of observation ;

for they come from Brussels to London and return. Nay, they have been known to fly from the Rhine to Paris. Sergeant Wilde took pigeons of the Rock kind to Hounslow, and they flew back to Guildford-street in an hour. They were taken in a bag, and could see or smell nothing by the way. On being let loose, they made two or three wide circles, and then flew straight to their dovecot. The Sergeant also knew of a cat, which a shopkeeper's apprentice, in Fore-street, had been desired to hang, and found he could not. He then took it in a bag to Blackfriar's Bridge, and threw it into the river—the cat was at home, in Fore-street, as soon as the apprentice. He might have made a circuit, but certainly the cat returned in an hour or two. The grocer's name was Gardner; the distance is certainly above a mile, and through the most crowded part of London. The case of bees, is referable to Instinct, clearly. Honey-finders in America trace their nests by catching two bees, carrying them to a distance, and letting them fly. Each takes the straight line towards the nest or hive, and by noting these two lines, and finding where they intersect each other, the hive is found. Now the bee is known to have a very confined sphere of vision, from the extremely convex form of her eye. She is supposed only to see a yard or so before her.

A. I fancy we must pass over the subject of migration, for a like reason. It seems still involved in much obscurity and doubt, though I take for granted, that no one now yields to Daines Barrington's theory, which denies it altogether.

B. Clearly no one; the facts are quite indisputable, as far as negativing that goes; and indeed his reasonings are so full of prejudice, or preconceived opinion, and his suppositions for disposing of the facts, so strained, that his argument never could have had much weight. One fact, seems, also, not to be disputed, and is referable to Instinct alone. I mean the agitation which, without any evident cause, comes on upon a bird of any of the migratory classes, at the appointed season of migration.

A. The communication with each other, which animals have by sounds or signs, can, I think, hardly be doubted.

B. The observations of Huber clearly show that ants have a kind of language by means of their feelers or antennæ; and every day's experience, seems to show this in other animals.

A. Some believe that they have a notion of what men are saying, and no doubt very strange and lucky guesses have sometimes been made, one of which I wrote you an account of. I had it from a most accurate and literal person, and it tends to prove that his shooting dogs had found out his intention of going into Nottinghamshire the day after. However, it is perfectly clear, that these things are referable to minute and exact observation of things, which escape us, in the greater multitude of our ideas and concerns. All this, however, only illustrates, the more, how well animals can profit by experience, and draw correct inferences from things observed by them.

B. Among other instances referable plainly to Intelligence, must be ranked the devices which one animal is known to fall upon, for benefiting by another's operations. The ant, enslaving workers, is the most curious instance, certainly. But the cuckoo laying in other birds' nests, and leaving her progeny to be brought up by them, is another. Nor can this be set down wholly to the score of Instinct; for there are abundant proofs of her also building, when she cannot find a nest, and then she lays in her own, and hatches and rears her brood. This curious and important fact, long disbelieved by vulgar prejudice, was known to that great observer, Aristotle, who says she sometimes builds among rocks, and on heights.[*] Darwin confirms this by the observations of two intelligent friends whom he cites.[†] The man-of-war bird is a still more singular instance of contrivance, for, though its food is fish, it has not such a form as to be fit for catching any, and therefore it lives piratically on the prey made by other fishing birds; hence the name we have given it.

A. Only think of our never having all this while said a word, or more than a word, of either the fox or the elephant, proverbially the two wisest of animals. Of the former's cunning, every day shows instances ; but that the elephant should be left to take care of a child, unable to walk, and should let it crawl as far as his own chain, and then gently lift it with his trunk and replace it in safety, seems really an extraordinary effect of both intelligence and care, and shows that fine animal's gentle nature, of which so many anecdotes are told by travellers in the East.

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[*] Lib. VI., c. 1.

[†] Zoonomia, Vol. XVI., p. 18.

B. The amiable qualities of brutes are not quite within the scope of our discussion, unless, indeed, in so far as whatever things are lovely may also be said to betoken wisdom, or at least, reflection. The natural love of their offspring, I should hardly cite in proof of this, because it seems rather an instinctive feeling. But the attachments formed between animals of different classes, a cat and a horse, a dog and a man, and often between two elderly birds, may be cited as interesting. One of these friends has been known to be unable to survive the other. I have heard this of two old parrots, upon the best authority..

A. We have said nothing of fishes, or of any marine animals.

B. Why of these our knowledge is necessarily very limited. That they have remarkable Instincts, some of them resembling those of land animals, is certain. The sepia, or cuttle-fish, ejecting a black or dark-brown fluid to facilitate his escape, resembles the stratagem of some beasts emitting an intolerable effluvia in the face of their pursuers. The whale, when attacked by the sword-fish, diving to such a depth, that his enemy cannot sustain the pressure of the water, is another wellknown example of defensive action. I used to observe, with interest, the wary cunning of the old carp, in the ponds, here : there was no decoying them with bait, which the younger and less experienced fish took at once. So little have men formerly undervalued the faculties of fishes, that Plutarch wrote an ingenious treatise in the form of a dialogue, on the question whether land or water animals have the most understanding.

A. How does he treat this odd question?

B. Here is his book; and certainly, as far as the first portion of the subject goes, where the merits of land animals are concerned, he sails before the wind. To his first remark, I willingly subscribe, that those hold the most stupid doctrine upon the subject, who say, that animals do not really fear, rejoice, remember, rage, &c., but only do something like fearing, rejoicing, &c.; and he asks what such reasoners would think were it also contended that animals do not see, but make as if they saw; nor hear, but make as if they heard; nor roar, but make as if they roared; and finally, do not live, but only did something like living. He then relates a great variety of facts, respecting the sagacity of animals, some of them evidently fabulous, (as the love of a dragon for a young woman,) and some, now proved to be erroneous; but he gives others, worthy of attending to. Thus, the contrivance of African crows, who, when the water was scarce, threw pebbles into deep cracks of the earth, so as to bring the fluid up towards the surface, and within their reach; the similar cunning of a dog, on board of a vessel; the like device fallen upon by elephants, to rescue one that had fallen into a pit; the astuteness of the fox, used by the Thracians as a kind of guide in crossing a river frozen over, to find out whether the ice is thick enough, which the animal does by stopping and listening to hear if the water is running near the surface; the judicious mode of flight, in which cranes and other birds of passage marshal themselves, forming a wedge-like body, with the strongest birds at the front angle or point. But when he comes to the other side of the question, and is to state the case for the fishes, we find a great falling off both in his facts and in his evidence. Besides telling very absurd stories about crocodiles in Egypt obeying the call of the priests and submitting to their influence, he dwells upon the sepia, whose escape in a black cloud of his own making, he compares to the tactics of Homer's gods; upon the cunning shown by fishes in gnawing lines to escape with the hook; nay, upon a story he tells of their helping one another to escape, when caught, which is plainly groundless; upon the torpedo, or electrical eel, giving shocks, which is clearly a mere physical quality, and no more indicates reason, than the shark using his teeth; upon shoals of fishes, like flocks of birds, forming themselves into wedges when they move from one sea to another, which is certainly true; upon the dolphin loving music, which is purely fabulous, as well as the feats of wisdom and philanthropy that he ascribes to this fish; finally, upon all the fables to be found in the poets respecting this fish. After reciting one of these, by way of proving his case in favor of marine animals, he innocently enough says, that although he had promised to relate no fables, he now finds himself, he knows not how, in the company of Cæranus and Ulysses, and so he brings his notable argument to a close.

A. How does he ultimately decide the question propounded?

B. With a verse of Sophocles, intimating that both sides have gained some advantage towards a common purpose; but the victory is given to neither, the umpire pronouncing that both the arguments, combined, overthrow the doctrine of those who deny Reason and Intelligence to animals generally.

A. There are no modern books which fully discuss this subject systematically, either as regards Instinct or Intelligence. One is exceedingly disappointed in consulting our best writers, whether metaphysicians or naturalists, with this view; and the omission is the less to be excused, because there are great opportunities of observing and comparing: this branch of knowledge is eminently suited to inductive reasoning; we live, as it were, among the facts, and have not only constant facilities for making our experiments, but are in some sort under a constant necessity of doing so.

B. Truly, it is, as you say. I have often felt this disappointment and this disapprobation. The works of metaphysical writers contain a few scattered suggestions, or dogmas, and with these they leave the subject. Naturalists, who could throw so much light upon it, confine themselves chiefly to the structure and functions of the organs, and leave the mental part of the subject out of view. Yet a physiologist, who also applied himself to this latter branch of the inquiry, would be the person best qualified to grapple with its difficulties and to throw light upon it. Therefore I learnt with extreme satisfaction that an able and learned professor of Natural History had given a course of lectures upon it at Paris, and was still more gratified, to find, that he soon afterwards published them. I speak of M. Virey's work; those two thick volumes, lying there, contain above a thousand pages on the Habits and Instinct of Animals; and to raise my expectation still higher, it professes by its title to deal in facts—for it is called, *Histoire des Mœurs et de l'Instinct des Animaux*.

A. Well; I suppose you rushed upon it, to slake your thirst?

B. As a traveller upon a delicious and copious spring, and found it a picture; or upon a luscious-looking large peach, and found my mouth filled with chalk. I have had these volumes here these two years, and I can barely now say I have been able to get through them. They are throughout not only written in the very worst style of French sentimental declamation, but they avoid all precision, all details, all facts, as something grovelling, common-place, and unimportant. The constant object is not to find out or illustrate some truth, to describe or arrange some phenomenon, but to say something pretty, far-fetched, and figurative. And all this, with an arrangement of the classes of animals, so methodical, that, on looking at the contents, and finding they proceeded regularly from the structure of the globe and the general qualities of its different products, to mammalia, then to birds, reptiles, fishes, and so, downwards, through the invertebrated animals, ending with zoophytes and molluscæ, you naturally expect under each head to have what the title promises, a History of the Habits and Instincts; and find nothing of the kind from beginning to end, but only trope after trope, one piece of finery after another, nothing but vague declamation long drawn out, an endless succession of the most frivolous sentimentality. Truly such a work, from so learned a naturalist, one who could so well have instructed and entertained us, had he but chosen to be plain and didactic, instead of being brilliant and rhetorical, where all eloquence and ornament are absolutely misplaced, is no small offence in the literary world.

A. I 'll assure you our French neighbors are not the only sinners in this particular. I have been somewhat mortified, of late years, at perceiving a tendency to fine writing and declamation among our own men of science, and I ascribe it, in some degree, to the more general diffusion of scientific knowledge, which naturally introduces the more popular style of composition. Our Society of Useful Knowledge has no sins of this sort on its conscience, because we correct, with unsparing severity, all we publish ; but you may perceive the tendency of popular explication to run in this bad direction, from the kind of matter that is often submitted to us for revision. I am sure I sometimes draw my pen through half a page of fine writing at a time.

B. I will engage for it you do, inexorably, whenever you find such outrages. My experience is precisely the same ; and I am just as severe on those parts, evidently the prime favorites of the learned and very able writers. But we originally set out with firmly resolving to be most rigorous in matters of taste, being aware, as you say, of the tendencies of popular writers. In truth, however, that vile florid style, darkens, instead of illustrating ; and while we never can write too clearly to the people, we never can write too simply, if our design be to write plainly and intelligibly. But in this piece of French declamation all is chaff, and hardly a grain can be gleaned out of the light and worthless matter.

A. Can you find nothing by sifting and bolting it ? I generally find something even in the worst books.

B. I will not say that these heavy volumes of light matter contain absolutely nothing; but wondrous little assuredly they have to reward the pains of searching. What can be more hateful, than a man of science unable to speak of granivorous animals without terming them Pythagoreans and Gymnosophists ; calling the crying baboon of *South* America a wild Demosthenes, the lion a generous prince, the jackal a courtièr; describing the nightingale as appealing to Heaven against the robber of her nest, and the crocodiles as the "sad orphans of Nature," because hatched in the sand; nay, carrying his ridiculous fancies into actual practice, seriously explaining the mild temper of one animal by the sweetness of its humors, and the ferocity of another by the acrid juices of its system—all a pure fiction in fact, as well as a gross absurdity in theory! Then mark the consistency of a philosopher—a consistency worthy of the veriest mob. He denounces, as the most atrocious of men, the experimenter on a living dog or rabbit, Fontana, or Majendie, I suppose, and afterwards speaks with the utmost composure of dividing a bee in two, in order to examine her honey-bag. Of the bee, indeed, he seems very moderately informed. He speaks of Aristarchus having devoted his life to the study of this insect, instead of Aristomachus; assumes to be true the notion long exploded of honey being collected from flowers, instead of a secretion in the stomach; will not believe that wax, too, is a secretion, though he refers unconsciously to Huber's experiment, of obtaining it from bees feeding upon sugar and water; and, to set off his modern natural history with a little false classical lore, must needs call the cells "their citadel, or the palladium of their republic."

A. Bad enough, in all conscience. But now give us the grain or two of wheat in all this bushel of chaff.

B. First, and this makes it more provoking, the author writes clearly and admirably, when he chooses to leave off declaiming. There is a long note upon vertebrated and invertebrated animals, showing, with much clearness and precision, that in the former, which have a cerebral and nervous system, Intelligence prevails; in the latter, Instinct. He maintains the specific difference of Instinct, and Reason or Intelligence, with great force and clearness; indeed, there seems nothing to find fault with in his statements here, except that he places the seat of Intelligence in the cerebral nervous system, and of Instinct in the ganglionic, and thus is forced to deny Intelligence altogether to insects, whereas we have seen that Huber's observations plainly show the bee to have the capacity of varying its means in accomplishing the end in view, when the circumstances vary; and this surely cannot be distinguished from Intelligence. Also he discusses, with perfect strictness of reasoning, the hypothesis of a very celebrated naturalist, no less than M. Lamarck, and, I must say, refutes, very satisfactorily, the theory of my most learned and worthy colleague, for whom we all must feel the most profound respect. He had been induced to suppose, that Instinct results from the habits originally acquired by animals, adapted to the circumstances in which they found themselves placed at the beginning of the creation, and that these habits occasioned an adaptation of their structure to particular operations, as well as a constant capacity and desire to perform them. Now, my only objection to M. Virey's refutation of this theory, which is merely the exploded doctrine of appetencies in a new form, is, that it requires no such elaborate answer to overthrow it. For, what do we see, in all Nature, which in the least entitles us to suppose any animal, at any period, to have had the power of altering his bodily structure, creating one part, and altering another, according to his wants? Besides, if animals, at their first creation, had so much power, and so much intelligence, as this theory supposes, why should this all cease, and leave them only possessed of blind Instincts, now? The reasoning, however, of M. Virey is sound, and does much credit to his acuteness.

A. But have you found, in his volumes, no facts; nothing to place among the phenomena which we are collecting, previous to resuming our discussion respecting the faculties of brutes?

B. Very little; and that so wrapped up in declamation, and so disfigured with figures, (if I may thus speak,) that there is no small difficulty in seizing hold of it. What he says of the architecture of squirrels, marmots, rats, and some other rodents, is new to me. I had only been aware of the beaver, as among this tribe, remarkable for ingenuity. But it seems these others excel all animals, in digging subterranean dwellings; they make compartments or chambers, which they line with clay, and cover with a roof from the weather ; in some of these chambers they stow vegetables, which they previously dry in the sun ; others they use for the reception of their young ; in others they sleep. He brings together some curious instances of swift and long-sustained flights of birds. Thus the smallest bird, he says, can fly several leagues in an hour ; the hawk goes commonly at the rate of a league in four minutes, or above forty miles an hour. A falcon of Henry II., was flown from Fontainbleau, and found, by its ring, at Malta, next day. One, sent from the Canaries to Andalusia, returned to Teneriffe in sixteen hours, a distance of near seven hundred miles, which it must have gone at the average rate of twenty-four miles an hour. Gulls go seven hundred miles out to sea, and return daily ; and frigate-birds have been found at twelve hundred miles from any land. Upon their migration, he states, as a known fact, that cranes go and return at the same date, without the least regard to the state of the weather, which shows no doubt, if true, a most peculiar instinct ; but these, and, indeed, all facts, which we find stated by a writer so addicted to painting and coloring, must be received with a degree of suspicion, for which no one but M. Virey is to be blamed. The accounts, however, of the swiftness of birds, I can well credit, from an experiment which I made, when travelling on a railway. While going at the rate of thirty miles an hour, I let fly a bee ; it made its circles as usual, and surrounded us easily. Now, if there was no current of air or draught to bear it along, this indicated a rate of ninety miles an hour ; and even allowing for a current, the swiftness must have been great. I should, however, wish to repeat this experiment before being quite sure of so great a swiftness in so small an insect.

A. Have you given all your gleanings from this work ?

B. I should, perhaps, add these two. We find in it, a curious passage from an old Spanish author, of the seventeenth century, giving a quaint and lively account of the sagacity of the beggars' dogs, at Rome ; and we also find the titles of some German works, on the faculties of brutes, which are truly curious, and show how great a degree of attention that laborious people have paid to the subject; but, at the same time, betray not a little of the characteristic boldness and enthusiasm of their speculations.

A. Does the Spaniard give any curious particulars of dogs?

B. Not, perhaps, any that surpass what we have been stating, from facts known among ourselves. But his account is diverting enough. "The blind man's dog," says he, "will take him to the places where he may best hope to get his alms, and bring him thither through the crowd by the shortest way and the safest; nay, he will take him out of the city, some miles, to the great church of St. Paul, as you go to Ostia. When, in the town, he cometh to a place where several ways meet, and with the sharpness of ear that the blind have, guided by some sound of a fountain, he gives the string a jerk by either hand, straightway will the poor dog turn, and guide him to the very church where he knows his master would beg. In the street, too, knoweth he the charitably-disposed houses that be therein, and will lead thither the beggar-man, who, stopping at one, saith his pater-noster; then down lieth the dog, till he hear the last word of the beadsman, when straight he riseth and away to another house. I have seen, myself, to my great joy, mingled with admiration, when a piece of money was thrown down from some window, the dog would run and pick it up and fetch it to the master's hat; nor, when bread is flung down, will he touch it, be he ever so hungry, but bring it to his master, and wait, till he may have his share given him. A friend of mine was wont to come to my dwelling, with a great mastiff, which he left by the door, on entering; but he, seeing that his master had entered after drawing the string of the bell, would needs do likewise, and so made those within open the door, as though some one should have rung thereat."

A. Upon my word, you have been amusing yourself, with making the old Castilian speak in old English. But *now*, I think, we may be said to have gone at sufficient length into the facts, and to have gathered together a collection, large enough for our purposes of speculation; nor have we perhaps much more to do with this, in that way. For can any one rationally doubt, that they evince in these brutes some faculties, at least, approaching in kind to our own—nay, and to such of our own as we are wont to prize the most, and to be the proudest of? No blind impulse of a mechanical kind, no mere instinct, or feeling, or operative principle, apart from knowledge, experience, learning, even intention,—can surely account for the things we have just been considering as done by animals; and one example, and an ordinary one, is as good as a thousand. The cat opening a door, from observing men do so before it; or the bird, from its own observation of the effect produced by solid bodies, sunk in water, raising the water by throwing in pebbles; or letting mussels fall to break the shells; these things surely argue a thinking and a reasoning process.

B. There seems little doubt of this; however, we may perhaps adjourn the further discussion, as we no longer require to be among our books, but may take our walk out in the sun, which is far from disagreeably hot to-day.

A. I have no kind of objection, and will meet you on the Terrace, as soon as I have written my letters.

BOOK, OR DIALOGUE IV. ANIMAL INTELLIGENCE.—(THEORY.)

WE accordingly finished our letters, and prepared to go out and walk about in the sunny exposure, which a north-west wind made agreeable, as in the north it often does, even at this season: where, as we walked about, he began in continuation of his last remark.

A. I know not, why so much unwillingness should be shown, by some excellent philosophers, to allow intelligent faculties, and a share of reason, to the lower animals, as if our own superiority was not quite sufficiently established, to leave all question of jealousy out of view, by the immeasurably higher place which we occupy in the scale of being, even should we admit the difference to be in degree, rather than in kind; because, when the difference of degree becomes so vast, there is hardly any more chance of encroachment or confusion, hardly any more likeness or comparison, than if the difference were radical, and in kind. Some writers, as D. Stewart, really seem to treat the question as one of an exciting nature, and almost to regard the purity of religious belief, as involved in the controversy. How is this, and why should it be?

B. It is possible, that the origin of the feelings, shown by those good and able men, resembles that of Descartes's absurd theory, of brutes being like machines, which, as far as he holds it, he avows to have proceeded from the notion that unless they are so, their souls would be immortal. But another reason may be assigned. The skeptical, or free-thinking, philosophers, always lowered human nature as much as possible. They regarded it as something gained to their arguments against religious belief, if they could show the difference to be slighter than is supposed, between men and brutes; and that there is a chain of being from the plant, nay, almost from inorganic matter, up to man. They seem to have had a confused idea, that this helped them even to account for the constitution of the universe, "without the hypothesis of a Deity," as Laplace is said to have termed it, when Napoleon questioned him on the remarkable omission in the 'Mécanique Céleste.' Thus much is certain, in point of fact, that those philosophers, and especially the French school, were fond of lowering the human intellect by raising that of animals; and while the priests were lavish of their admission, that our moral nature is utterly corrupt, but claimed for our intellectual capacity to be only a little lower than the angels, the society of the Encyclopédie, and the coterie of Baron d'Holbach, were fond of levelling the intellectual distinction between immortal and confessedly mortal beings, though they denied the moral depravity of their race, with perhaps no very strict regard either to the evidence of their consciousness or of their observation. It thus appears, that this theory of a difference in kind, is found in company with that of skepticism, just as some other theories are usually coupled with it, also; for example, the selfish system, philosophical necessity, expediency, materialism,—all of which are held by Hume, Voltaire, Helvetius, Diderot, and other free-thinkers; yet all of which, are also held by some as determined believers, as any that are to be found in any church. Priestley, for instance, held all these doctrines, and Paley all but the last. Hume's opinion on the reason of brutes cannot be doubted, from some accidental remarks interspersed in his writings. Helvetius, a materialist and skeptic both, has explicitly stated, that if the arm of man had chanced to terminate in the foot of a horse, he would still have been found wandering about as the tenant of the woods.* The company, in which the opinion has been found, has thus greatly disinclined pious men towards it. Professor Robinson, in his attacks on the French school, is no where more severe upon them, than where he impeaches them of endeavoring to lower the dignity of human nature;† and, undoubtedly, such attempts may be made, in a manner to hurt the interests both of religion and of morals.

A. Has not Lord Monboddo given great offence, of the same kind, and in the same quarters?

B. Possibly he has; although from his station as a judge, and a man of most loyal political opinions, and also from his being an orthodox believer, at least as far as professions go, he has been less blamed than the rest. He was an admirable Grecian, such as, in modern times, Scotland has very rarely produced; and there is an infinite deal of ingenuity and subtlety, as well as learning in his writings, with a constant display of most correct taste, in judging of the ancient controversies. But his theory has subjected him to great ridicule, not so much from his holding that there is a gradation in the whole scale of beings, and that the mental faculties of man are found in the minds of brutes, as from his denying any specific difference, even in body; and holding that originally men were fashioned like monkeys, and lived, like them, wild and savage.

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* De l'Esprit.

† Proofs of a Conspiracy.

A. I could much more readily understand this doctrine giving offence and scandal, as heterodox, than the other; for it seems not very easily reconcilable either to our religion, or indeed to almost any other, received among civilized nations.

B. I consider it a thing just as little supported by the facts, as it is repugnant to all known systems of theology. But my objection to it, is really not founded upon its tendency to lower human nature. On the contrary, I doubt if it does not rather exalt our faculties, beyond all the ordinary doctrines, and draw a broader line of distinction between us, and the lower animals, than that which it was intended to efface. For surely, if we have not only by our intelligence made the great progress from a rude to a refined state, from the New Zealander to Laplace, and Newton, and Lagrange,—but have also, by the help of the same faculties, made the progress from the state of monkeys and baboons, while all other animals are the same, from one generation to another, and have made not a single step for sixty centuries, and never have attempted, in a single instance, to store up, for after times, the experience of a former age, our faculties must needs be immeasurably superior to theirs. In short, the only question is, as to the nature of the difference.

A. I can well suppose a difference, merely in degree, sufficient to explain any diversity of condition or result. We have only to compare individual men together, to perceive this. It is admitted, that reason, nay that the power of forming abstract ideas, as well as drawing inferences from premises, is possessed by persons, whom yet you shall in vain attempt to teach the simplest mathematical demonstration. Then their faculties only differ, in degree, from those by which Pascal learnt geometry, without a master or a book, and Newton discovered fluxions, and Lagrange and Euler the calculus of variations. It may truly be said, that there is no difference, in kind, which could make a greater diversity, in the result.

B. It may, indeed, be truly so said; but it may also added, that there is not a greater difference, call it in nd or in degree, between the person whose obtuseness u have supposed, and a sagacious retriever, or a clever e, than between the great mathematicians you have med, and that same person. Locke, whose calmness understanding was equal to his sagacity, and never owed his judgement to be warped by prejudice, or card away by fancy and feelings, seems to have held this nion, and indeed to have allowed some reason to anils. "There are some brutes," he observes, "that m to have as much knowledge and reason, as some t are called men;" and he goes on to say, that there such a connexion between the animal and the vegetae kingdom, as makes the difference scarce perceptible, tween the lowest of the one, and the highest of the ther.

A. You quoted Addison's paper, upon Instinct, yesterday, in proof of his taking the Newtonian view of the subject. What does he say as to the Reason, and generally the Intelligent faculties, of animals?

B. He is, as you are aware, no very great reasoner. Accordingly, he is very wavering and inconsistent on this subject, and encounters it with prejudice. At one place, he says, reason cannot be the cause of brutes acting as they do; and then, after seeming to deny it, he only adds a kind of admission that they have reason: "for," says he, "were animals endued with it, to as great a degree as man," &c. And again, in the same paper, he seems to deny it, altogether. "One would wonder to hear," he says, "skeptical men disputing for the reason of animals, and telling us it is only our pride and prejudices, that will not allow them the use of that faculty." This is exactly the notion, to which I was a little while ago imputing the unwillingness of so many reasoners, to allow brutes their fair share of intelligence. You see Addison considers it the natural course of a skeptic; yet surely, Locke was as firm a believer as himself, and certainly a far more reflecting and intelligent one.

A. Perhaps we may as well consider, before going into the question, by what kind of logic the argument is to be conducted, by what sort of evidence we are to try the cause.

B. I presume there can be no doubt here. We must examine it according to the rules of inductive science. The facts are before us. Some we gather from observation—those relating to animals; some, as those respecting the nature of the human mind, we ascertain by our own consciousness, or at least, chiefly by that, though in some sort, also, by observing other men's conduct, and communicating with them; but having no means of communicating with animals, we are reduced to our observation merely; and then we naturally draw the inference, that, because the same things done by ourselves, would be known by us to be done from certain mental powers, therefore we ascribe those powers to the animals. This conclusion, as to ourselves, is certain, because we know and feel it to be so, by our own consciousness. With respect to animals, it is not nearly so certain, because we cannot either enter into their minds, as we do into our own, or communicate with them, as we do with our fellow-men. Nevertheless, by varying our observations on them, by making experiments on their faculties, by placing them in new and arbitrary combinations of circumstances, we can reduce the chances of error, to a very small amount, and render our inferences as highly probable, as most of the propositions of contingent truth are.

A. It is not, however, necessary, that we should now go into an investigation of the nature of the human faculties. Our researches are, in their nature, comparative only.

B. Certainly; and therefore, agreeing with you, I would begin, by laying down this position, that all we have to do, is to grant or to deny the existence of certain mental faculties, and to ascertain the meaning of the terms, which we employ in expressing these. Whatever those faculties may be, in us, all we are now to consider, is, whether or not the brutes have the same, or in any degree.

A. I think it quite right, and really for our safety, in conducting the inquiry, to lay down a second preliminary principle, or caution, namely, that we have no right to argue from the mere effects produced by certain endowments, or by any given combination or modification of these. Thus, when we see what has been achieved by man, and contemplate the extraordinary monuments raised by his industry, his activity, and his intelligence, and the power which he has acquired over the operations of Nature and of all other animals, profiting so largely by both; and when we compare this, with the feeble state of those animals, their having no accumulation of either knowledge or possessions, and gaining nothing upon man or by man, we are drawing a contrast, which really proves nothing; because it is just as easily accounted for, by supposing the two classes extremely different in degree, as by assuming that they differ in the kind of their faculties. Thus, to take a common instance, and one which Adam Smith himself gives, as marking a great difference between us and the brutes, they have no appearance of barter; but, if barter arises from comparing ideas together, and forming a conclusion from the premises, and if, from other facts, animals appear to possess that power, there being no positive barter, only shows that their judgement or reasoning faculties are weaker than ours, or that for some other reason, it is immaterial to the argument what, they have not acquired that particular result of the reasoning faculty.

B. I entirely agree in this general position, holding that the neglect of it has been one main cause of the errors into which philosophers have fallen on this question; I must, however, doubt the correctness of the position, that the brutes are wholly ignorant of barter. No one, as Smith says, ever saw one dog barter a bone with another. But many of the operations of both dogs and horses in dividing their labor, and of insects, as ants, in helping each other, seem referable to a principle not to be easily distinguished from barter. The division of labor is clearly to be observed among them. Of course, I do not mean that comminute division by which bees work together, and in which they incalculably excel ourselves; for that we have classed as instinctive and unintentional, and therefore it cannot enter into our present argument. But horses plainly help one another in drawing, and take different parts of the work: so do dogs, in the chase. However, to leave no doubt about it, and allowing beavers to act instinctively, the wild horses sleeping and watching by turns, is a clear and unequivocal instance of the division of labor. But I admit your position—that if any thing, which is the result of a faculty, proved already to be one of the animal mind, is not possessed by them, this is no argument against their having that faculty. It may lead us to be the more cautious in examining the proofs by which their possession of the faculty is established; but that is all. Indeed, such distinctions are taken upon no more philosophical ground than he would have for his classification, who should make two divisions of metals or of water, one the solid, and another the fluid, accordingly as they had different temperatures.

A. I hold it to be a part of the same preliminary position, that if brutes are shown to possess any given simple faculties, their not having the power of doing things, only to be accomplished by combinations of these simple powers, does not impeach the proposition, already established, of their having those simple powers. For it would only show, that they have not the combination, though they may have the separate powers. Does any other proposition occur to you, as convenient to be laid down in the outset?

B. I should say this, which is perhaps rather a corollary from the last, that we must carefully distinguish between simple and composite faculties, as they are called. Indeed, I deny the accuracy of this form of speech, and I believe it tends much to error in metaphysical speculations. No system of psychology, ancient or modern, sanctions it; neither those of Hartley, Priestley, Berkeley, nor that of Reid and Stewart, and Brown, although I think it has been much encouraged by the speculations of these last, and their separate treatment of our mental powers under distinct heads, how necessary soever this was for the elucidation of the subject. The mind, being one, and entire, and invariable, without parts or composition, acts always as one being. It recollects, praises, judges, abstracts, imagines; and when you say, that it exercises a compound, or complex, or composite faculty, as for example, the imagination, you only mean that it first exerts one faculty, then another, and then a third. We never should call the process, by which chemists bleach vegetable substances, a composite operation, because they first make oxymuriatic gas, then mix lime with water, then, by agitation of the water exposed to the gas, cause lime to combine, and then expose the vegetable fibre to this compound liquor; we say that these are so many successive operations performed, and not one complex operation. And so imagination is not one compound faculty, nor is imagining one complex operation of the mind. But that mind in succession remembers, abstracts, judges, or compares, ideas, and reasons or compares judgements; and the whole four successive operations form imagination: to which you may add, the further operation of taste, which, rejecting one and selecting other results of imagination, produces the fruits of refined or purified fancy; if, indeed, this taste itself be any thing but a sound exercise of judgement—a judgement refined by experience, that is, by constant attention to what is pleasing, and what disagreeable. The rapidity with which all these separate operations are performed by the mind, neither prevents them from being in succession and separately performed, nor at all shows the mind to have composition or parts. Giving names to certain combinations, or rather successions of operations, and not to others, may be correct; but, it must be admitted, is somewhat capricious. We talk of imagination, as if it were one operation, though it is many; and yet we give no separate name to several other successions, as rapid, of our mental operations. So as to our moral feelings. We speak of conscience as one; yet it is, as Smith describes it, a succession, (he says a compound,) of several, among which, pity for the party injured, and fear of the consequences to ourselves, are the chief. Yet we give no name to the reflection on past enjoyments, which is as quick a succession of several emotions,—namely, recollection, comparison of the present, and sorrowing for the contrast. However, as regards our present purpose, the simplest part of the proposition is, that any given simple faculty or single operation of the mind being found to be possessed by animals, the circumstances of their not possessing the compound exclusively, or several combined, or a successive operation of different faculties, is no proof against their having the simple ones. Thus, if they have no fancy, it is no proof that they have no memory or judgement; because they may have these without having abstraction, which is one of the faculties that go to make the imaginative process. But it is also no proof of their being without abstraction, and all the other simple or single faculties; for it only proves that they have not the power of using these faculties together, or rather in quick succession, and for the same joint purpose. And should they have the simple or single, without having the compound faculties or processes, this would again argue no specific difference, but rather a diversity of degree.

A. I think these preliminary positions not only have cleared the ground for us, but helped us a good way on our journey. There appears hardly much more to reason about now. The subject has been a good deal enveloped in mist and smoke, from confusion of ideas, and from prejudice and high feeling. These being blown away, it seems pretty clear what the structure is that we are to examine.

B. Before going to the brute faculties, let us just cast a glance over the faculties which have been enumerated as belonging to ourselves, and see if they should not be a little simplified—Sensation, Perception, Consciousness, Memory, Abstraction, Imagination, Judgement, Reasoning, to which have been added, Taste and the Moral sense; and Mr. Stewart thinks these not enough, adding among others, the power of connecting general or abstract signs with the things signified. Now suppose we admit the correctness of calling a state of mind in which it is purely passive, an active power or faculty, as *Sensation*, which is merely the effect produced upon the mind by the operation of the senses, and involves nothing like an exertion of the mind itself, any more than receiving a hurt or a gratification passively, is any exertion of the body, although the operation whereby that reaches the mind may be termed bodily exertion; then it will follow, and not otherwise, that Sensation is a faculty. But Perception is no doubt an active exertion of the mind. *Memory* differs from Recollection, as Sensation does from Perception. The state of mind in which one idea calls up another, or a present state of mind influenced by a past state, is Memory. The exertion by which the mind voluntarily induces the present state from the past, is Recollection. The one is the *sensation*, the other the *perception* of the past, as sensation and perception are of the present.

A. Is not Perception an inference from Sensation? I have the sensation of solidity or of smell, and I perceive either the solid, resisting body, and the odorous body, or I perceive the solid or odorous quality, that is, I infer a being from the sensation; or I infer a quality; the former seems a simple inference, the latter an inference, coupled with an abstraction.

B. I do not incline altogether to this opinion; but, at any rate, it will not apply to Memory and Recollection; for Recollection is not an inference from Memory; is not an effort by which the mind throws itself into the state, into which it might have been brought, by the former ideas recurring of themselves. In Perception, we do not voluntarily throw the mind into the state of Sensation; we draw an inference from that sensation, according to your theory. But I think it pretty clear that there is something between the sensation and the inference—the simple apprehension and the conclusion drawn. The latter is clearly an inference, that an external being exists which created the sensation and the perception. But I think there is also a perception upon the sensation, and which cannot certainly exist without it. However, be this as it may, to our present purpose it makes no difference, except as far as there can be no doubt of the mind being in a much more passive state in the two conditions of feeling and remembering, than in the other two of recollecting and perceiving.

A. Then of Imagination we have already disposed. It consists of the successive, though rapidly succeeding operations of other faculties, whereby we create or combine new ideas, that had no previous existence, abstracting the qualities of one object, to clothe another with them. But Abstraction we may allow to be a simple operation, and one of the most important. What do you make of two that I do not remember you to have named, Attention and Conception ?

B. I omitted them purposely. I can see really nothing in Attention, but the degree in which certain other faculties operate. It is only the intensity with which I perceive. Possibly there may be some good from considering it as the difference between Perception and Sensation ; in the latter case, the mind passively receives the impression of the senses ; in the former, it fixes itself steadily upon those impressions, so as to feel them, by a voluntary effort, more acutely. As for Conception, which used formerly to be called Simple Apprehension, it is only the forming ideas of objects neither presented by the senses nor by the imagination ; and I am unable to separate it from Memory and from Abstraction—from Memory as far as it deals with former ideas, from Abstraction as far as it deals with quality, apart from the objects remembered or imagined.

A. Then Judgement, being the comparison of ideas, and Reasoning, the comparison of judgements, that is, of the ideas arising from the former comparison, may be set down as one faculty—that of Comparing ; and I conclude you make quick work with Taste and the Moral sense, of which the one gives us preferences among objects of mental gratification, and the other among objects of moral approbation ?

B. They are both evidently exercises of the judging and reasoning powers,—say the comparing powers, according to two standards,—the one, the sense of beauty or fitness, of what is pleasing or agreeable ; the other, the sense of what is just and right. But whether this last sense is natural or acquired, and how acquired, is a question that has long divided philosophers, and which will very certainly never be determined. Nor is it more easy to determine the other, which is quite a kindred one, how it is that our taste is formed, and whether it be natural or acquired. All that we can say on this subject, is, to remark the little practical importance which belongs to either question, and to state, that, as far as our present discussion is concerned, the only faculty involved in either the one or the other, is that by which we compare different ideas.

A. Our enumeration, then, of mental faculties, seems to resolve into Perception, active or passive; Memory, active or passive; Consciousness, Abstraction, and Comparison; then how do we place animals, as to the first?

B. Clearly no animal, nothing having life, can be conceived to exist without Passive Perception, at all events, and hardly any, without Active Perception, also. Consciousness, too, seems a necessary quality of every mind; it is the knowing one's own existence; so Memory, of the passive kind, must exist in every mind; without Consciousness and Memory, no animal could know its own personal identity; and no acts could be done by it, upon the supposition of that identity. With respect to Active Memory and Conception, if this is to be held a separate faculty, it is implied in Comparison, or in judgement and reasoning; so that our inquiries come to be confined within sufficiently narrow limits. Do the lower animals possess Abstraction and Comparison? I will at once begin with Abstraction, because it is the power most generally denied to brutes; and this arises, as I conceive, from an ill-grounded notion of its nature, and from a supposition that it is a faculty of a far more refined nature, subservient to operations of a much more difficult kind, than the truth will warrant us in affirming. The truth appears to be, that there are, if not two kinds of Abstraction, an active and a passive, yet certainly some degrees of Abstraction so easy and even unavoidable, that we can hardly conceive any mind incapable of forming them. But, on the other hand, the very highest and most difficultly attained reach of human thought is connected with Abstraction. Observing this, philosophers have passed all under one name, and because the brutes could not conduct algebraical investigations, or metaphysical reasonings, have denied them all power whatever of forming abstract ideas.

A. To a certain degree, this is no doubt true. The abstraction by which we reason upon m and n or x as only numbers ; deal with x the unknown quantity, multiplying it and speaking of m times x, or dividing it and speaking of one n^{th} part of x, is no doubt a high and refined reach of thought ; but so is the forming to ourselves an idea of abstract qualities ; indeed I know not if, when we reason about m and x, we do more than mechanically deal with the letters ; whereas in reasoning of color or smell, as abstracted from the rose, with which we always have seen them conjoined, and forming to ourselves the idea of something in the abstract, which we have only ever seen in the concrete,—of some ideal existence, of which, in actual existence, we have never known any thing, nor can know,—we really appear to go a step further. Now do you maintain that Abstraction is ever otherwise than a difficult and painful operation ?

B. First of all, be pleased to observe that many philosophers altogether deny, even to man, the power of forming abstract ideas. The dispute of the *Nominalists* and *Realists*, so well ridiculed by Swift, or rather by Arbuthnot, in Scriblerus, is as old as metaphysical inquiries, under one name or another. They consider it impossible for us really to form these abstractions, and hold that we only are using words and not dealing with ideas, just as you seem to think we do in algebraical language. Mr. Stewart is among those who conceive that we think in language. My opinion, if against such venerable authority I may venture to hold one, is different. I think we have ideas independent of language, and I do not see how, otherwise, a person born deaf and dumb and blind can have ideas at all ; which I know they have, because I carefully examined the one, of whom Mr. Stewart has given so interesting an account. Indeed, he has recorded the experiment of the musical snuff-box, which I then made upon this unhappy but singular boy. But next I am to show you that Abstraction, independent of algebra, or metaphysical reasoning, altogether, is neither difficult nor painful. Without Abstraction, we cannot classify in any way, or make any approach to classification. Now I venture to say, that no human being, be he ever so stupid, is without some power of classification, nay, that he is constantly exercising it with great care, and almost unavoidably, and acting upon the inferences to which it leads. He can tell a man from a horse. How? By attending to those things in which they differ. But he can also tell a stone from both, and he knows that the stone is different from both. How? By attending to those things in which the two animals agree, and to those things in which they differ from the stone. So every person, having accurate eyes and the use of speech, can call a sheet of paper and a patch of snow, both white; a piece of hot iron and of hot brick, both hot. He has therefore the idea in his mind of color and of heat in these several cases, independent of other qualities, that is, abstracted from other qualities; he classifies the white bodies together, independent of their differences; the hot bodies, independent of theirs; and he contrasts the white metal with the white snow, because they differ in temperature, without regarding their agreeing together in color. All this is Abstraction, and all this is quite level to the meanest capacity of men. But is it not also level to brute intellect? Unquestionably, all animals know their mates and their own kind. A dog knows his master, knows that he is not a dog, and that he differs from other men. In these very ordinary operations, we see the animal mind at one time paſsing over certain resemblances, and fixing on differences; at another time disregarding differences and fixing only on resemblances. Nay, go lower in the scale. A bull is enraged by a red color, be the form of the body what you please. A fish is caught by means of a light, be it of any size or any form.

A. These things, which you last mention, are mere sensations. The red light or the flame impresses the retina, and affects the animal's sensorium, his brain—irritating the quadruped, and attracting the fish.

B. What then? Other sensations pass to his mind, through his senses, at the same time. He has the sensation of form, as well as color; yet he passes this entirely over, and only considers the color. However, take those cases in which animals are attracted to certain places. They are hungry, and go to a certain field to eat, without the least regard to its position or its shape; because it agrees with other fields in bearing the food which the beast is in quest of. Flies approach the light, because they believe it to be the open air where they wish to go. So the bird never throws stones into a river or puddle, to raise the water; but it does throw them into the ewer. It abstracts water from the thing containing it; and could not reason upon the effects of the operation without a process of Abstraction. Indeed, upon the footing on which you would put it, I know not that all our own abstract ideas may not in the end be resolved into sensations and their immediate consequences. I know of no evidence that you have of our abstract ideas being formed in any other way, except on our consciousness, and our continual communication of ideas and experience, through speech. In the case of the brute, we have all the same phenomena, and, excluding the operation of blind Instinct, we are forced to the like conclusions.

A. I think we may go a step further; have not animals some kind of language? At all events they understand ours. A horse knows the encouraging or chiding sound of voice and whip, and moves or stops accordingly. Whoever uses the sound, and in whatever key or loudness, the horse acts alike. But they seem also to have some knowledge of conventional signs. If I am to teach a dog or a pig to do certain things on a given signal, the process I take to be this. I connect his obedience with reward, his disobedience with punishment. But this only gives him the motive to obey, the fear of disobeying. It in no way can give him the means of connecting the act with the sign. Now connecting the two together, whatever be the manner in which the sign is made, is Abstraction; but it is more, it is the very kind of Abstraction, in which all language has its origin—the connecting the sign with the thing signified; for the sign is purely arbitrary, in this case, as much as in human language.

B. May we not add that they have some conventional signs among themselves? How else are we to explain their calls? The cock grouse calls the hen; the male the female of many animals. The pigeon, and the fieldfare, and the crow, make signals; and the wild horse is a clear case of signals. All this implies not only Abstraction, but that very kind of Abstraction which gives us our language. It is in fact a language which they possess, though simple and limited in its range.

A. As to the power of comparing, what is commonly called Reason, *par excellence*, [by way of eminence,] comprising Judgement and Reasoning, this needs not detain us very long. The facts here are not well liable to dispute. There is no possibility of explaining the many cases which we began by going over without allowing this power. They all prove it in some degree. Several of them show it to exist in a very considerable degree. The acts of some birds and monkeys cannot be accounted for by Instinct; for they are the result of experience; and they are performed with a perfect knowledge of the end in view; they are directed peculiarly to that end; they vary, according as the circumstances, in which they are performed, alter, and the alteration made is always so contrived, as to suit the variation in the circumstances. Some of these acts, show more sagacity, according to Mr. Locke's observation, than is possessed by many men. The existence of a comparing and contriving power is therefore plain enough. And, on the whole, I conceive that a rational mind cannot be denied to the animals, however inferior, in degree, their faculties may be to our own.

B. That inferiority is manifestly the cause why they have made so little progress, or rather have hardly made any at all. Some little is proved by such facts as Mr. Knight has collected; but they are only exceptions to the rule which has doomed them to a stationary existence.

This difference, however, is merely the result of the inferior degree of their mental powers, as well as the different construction of their bodily powers. The want of fingers, endowed with a nice sense of touch, is an obstruction to the progress of all, or almost all the lower animals. The elephant's trunk is no doubt a partial exception, and, accordingly, his sagacity is greater than that of almost any other beast. The monkey would have a better chance of learning the nature of external objects, if his thumb were not on the same side of his hand with his fingers, whereby he cannot handle and measure objects as we do, whose chief knowledge of size and form is derived from the goniometer [angle measurer] of the finger and thumb, the movable angle which their motion and position give us. Insects work with infinite nicety, by means of their antennæ, [feelers ;] when these are removed, they cease to work at all, as Huber clearly proved. Clearly, this different external conformation, together with their inferior degree of reason, is sufficient to account for brutes having been stationary, and for their being subdued to our use, as the Deity intended they should, when He appointed this difference. To argue from the complex effect of all the faculties, bodily and mental, in giving different progress or power tò our race and to theirs, and to infer from this difference that there is an essential and specific diversity in our mental structure, nay that they have not one single faculty the same with ours in kind, is highly unphilosophical. It is, indeed, contrary to one of the fundamental rules of philosophizing, that which forbids us needlessly to multiply causes. For we are thus driven to suppose two kinds of Intelligence, human and brutal, and two sets of faculties, a Memory and a quasi Memory, as the lawyers would have it—an Abstraction and Reasoning properly so called, and something in the nature of Abstraction and Reasoning, but, though like, yet not the same.

A. There is one matter, to which we have not as yet adverted, but, after having considered the intelligent as well as instinctive powers, we may now as well do so. *I mean* the diversity, in the operations of the latter, and the perfect sameness, of the former—a sameness in all the operations of any given individual animal, and likewise of each of the species.

B. This is well worthy of consideration. When trying to explain instinctive operations, upon the hypothesis of an intelligent principle acting under the impulse of sensations, I found in this perfect sameness and regularity of its operation, a considerable difficulty, though not, perhaps, an insuperable one ; not, certainly, so great a difficulty as those we have considered.

A. How did you endeavor to explain, on that hypothesis, the regularity of Reason or Intelligence ?

B. The absolute sameness of moral and intellectual character, and the limited sphere of ideas and events, will account for much. We see far less diversity of action and speech among peasants of a very confined knowledge and very limited range of pursuits, than among persons of a higher degree of education and superior station in life. But still, there is a great diversity. Taking, however, two men of most perfect resemblance in all their faculties, and all their feelings, similarly constituted in both body and mind, they would probably act nearly, if not entirely, alike. Whatever made one do a thing, would make the other, and we must suppose them to be placed in perfectly similar circumstances, so that the same things would happen to both. Chance is here to be put out of view; because it only means ignorance of motives and circumstances, and assumes a diversity in these unknown to us, which by the supposition is here excluded. Suppose these two individuals thus placed in like circumstances, as to food and building materials, why should they eat differently, or make different habitations ? What is there to make the one choose a plant which the other does not choose ? or form a hut, in any particular different from the other ? If one kind of food was nearer the one, and another nearer the other individual, they might choose differently ; but this assumes that both kinds are agreeable to the constitution of their palates.

A. As long as providing for merely physical wants, was their whole occupation, it is probable that both would act alike, except that, if any difficulty occurred to be vanquished, I am not at all sure of their adopting the very same means to overcome it. One might break a nut, with his teeth, another with a stone, or by bruising two nuts together. But there is the same diversity in the conduct of animals, where they act by intelligent principles. The general resemblance of their proceedings, is explained, by the consideration you are stating, in the case you put of the boys. Their instinctive operations would never vary, in the least particular. When they came to reason, or speculate, or converse, the sameness would probably cease. It seems inconsistent with imagination and with free will; yet of this I speak doubtingly, considering the hypothesis you have made, of faculties and feelings, perfectly alike in all respects.

B. Certainly, you ought to speak doubtingly, when such is the hypothesis that is now binding us. I do not see how, even in reasoning, any thing should ever come into the mind of the one, that did not suggest itself to the other. But our hypothesis is not easy to remain under. Suppose, to make the case like instinct, two untaught children, in different parts of the world, viz., one in China and the other here, to be placed in a situation where the same kinds of food and building materials were placed, and a variety of each, we may assume that similar tastes and constitution of mind and body would make them eat the same things, perhaps choose to shelter themselves by building, rather than by going into caves, possibly to build with the same materials, selected out of a number; but it is much to say, that they would exactly preserve the same figure, and size, and proportions, in the huts they made. Each would certainly make blunders, and work inartificially; and it is difficult to fancy them exactly making the same blunders, deviating from the straight line or the circle, by the same quantity of aberration, and from the perpendicular, by the same angle: yet the bee, in China and in England, makes the same angles, and forms cells with the same proportions, and raises the grub the same height from the liquor provided for its nutriment, so as to let it have access to the liquor, without incommoding or drowning it.

A. When instinct is interfered with, by obstacles interposed, the animal's intelligent powers are brought into action, and then the uniformity and perfect regularity ceases. This seems to present under this head, as well as the other head of knowledge and design or intention, a sufficiently marked distinction.

B. Certainly: and it is to be observed that the more sagacious any animal is, the greater variety is perceived in his actions and habits. Thus, the elephant and the dog present general resemblances, throughout each species; but the instances of sagacity or reason, which the different individuals exhibit, are sufficiently various: whereas, there is no more diversity in the ordinary working of the bee, than in the operations of crystallization, or the secretion of the sanguiferous or the lacteal system. In truth, we may compare the two cases together. Instinct seems to hold the same place in the mental, which secretion and absorption do in the physical system. Intelligence or reason will sometimes interfere with Instinct, as our voluntary actions will interfere with the involuntary operations of secretion. But the instinctive operation proceeds, whether the animal wills or no—proceeds without his knowledge, and beyond his design; as secretion goes on in our sleep, without our knowledge, and without any intention on our part. So, as secretion goes on, without any help from us, or any direct cooperation, Instinct works without any aid from Intelligence. But there is this difference, in the connexion of will or Intelligence with Instinct, and the connexion of voluntary action with secretion—that the Instinct seems subservient to the Intelligent will, far more than the secreting power is to the voluntary action. The bee, when obstructed, applies his Instinct, as it were, to overcome the obstacle, whereas we cannot alter, at will, the course of secretion; we have some direct power over it, but very little.

A. One thing seems quite clear, that upon any view of this great question, whatever theory we adopt, all leaves the inference of design untouched; nay, the more we inquire, the more we perceive that all investigation only places in a stronger light, the conclusion from the facts to a superintending Intelligence.

B. Beyond all doubt, it is so. The whole question is one of relations and connexions. Adaptation, adjustment, mutual dependence of parts, conformity of arrangement, balance, and compensation,—every where appear pervading the whole system, and conspicuous in all its parts. It signifies not, in this view, whether we regard Instinct as the result of the animal's faculties actuated by the impression of his senses; or as the faint glimmerings of Intelligence, working by the same rules which guide the operations of more developed reason; or as a peculiar faculty differing in kind from those with which man is endowed; or as the immediate and direct operation of the Great Mind, which created and which upholds the universe. If the last be, indeed, the true theory, then we have additional reason for devoutly admiring the spectacle which this department of the creation hourly offers to the contemplative mind. But the same conclusion, of a present and pervading Intelligence, flows from all the other doctrines, and equally flows from them all. If the senses so move the animal's mind, as to produce the perfect result which we witness, those senses have been framed, and that mind has been constituted, in strict harmony with each other, and their combined and mutual action has been adjusted to the regular performance of the work spread out before our eyes, the subject of just wonder. If it is Reason, like our own, which moves the animal mechanism, its modification to suit that physical structure, and to work those effects which we are unable to accomplish, commands again our humble admiration, while the excellence of the workmanship, performed by so mean an agent, impresses us with ideas yet more awful, of the Being who formed and who taught it. If to the bodily structure of these creatures, there has been given a Mind wholly different from our own, yet it has been most nicely adapted to its material abode, and to the corporeal tools wherewith it works; so that, while a new variety strikes us in the infinite resources of creative skill, our admiration is still raised, as before, by the manifestation of contrivance and of expertness which every where speaks the governing power, the directing skill, the plastic hand.

Nor is there upon any of these hypotheses, room for doubting the identity of the Great Artificer of Nature. The same peculiarity, every where is seen to mark the whole workmanship. All comes from a Supreme Intelligence; that intelligence, though variously diversified, preserves its characteristic features, and ever shines, another, and the same.

NOTE TO THE DIALOGUES.

In Dialogue I., the Instinct of the duckling hatched under the hen, and of the chicken in the oven, is mentioned. The two following facts have occurred, since that discussion was ended.

When a sow farrows, the pigs are expelled with some force, and to a little distance. Each pig instantly runs up to one of the teats, which he ever after regards as his own peculiar property, and when more pigs than teats are produced, the latter ones run to the tail of some of the others, and suck till they die of inanition.

Mr. Davy, in his account of Ceylon, mentions a remarkable Instinct of the alligator. He saw an egg, in the sand, just ready to crack, and broke it with his stick. The animal came out, and made at once for the river. He held his stick before it, and immediately the reptile put itself in a posture of defence, as an adult alligator would have done, in like circumstances.

In Dialogue III., there is some doubt expressed, as to the water-moth loading its case, if too light in the water, with a kind of ballast. The larvæ of the *Phryganea* are stated by Mr. Lyell to do this habitually, and to use freshwater shells for their ballast. This gives rise to many masses of calcareous matter in the tertiary formations. As many as one hundred small shells are found surrounding one tube. (*Principles of Geology*, vol. ii. p. 232.)

In Dialogue IV., some remarks are made upon Hereditary Instincts. Mr. Roullin has related a similar instance of such Instinct, in the hunting dogs of Mexico. Were they to attack the deer in front, whose weight exceeds their own, six fold, they would be destroyed, and have their backs broke, as happens to other dogs, ignorant of the manœuvre, which consists in attacking from behind or laterally, and seizing the very moment when the deer, in running, rests upon two legs. The dog then takes hold of him by the belly and throws him over. The dog of pure breed, inherits this stratagem, and never attacks otherwise. Should the deer come upon him unawares, (from not seeing him,) he steps aside and makes his attack, at the proper time, in the animal's flank; other dogs, however superior in sagacity and strength, make the attack in front, and have their necks broken by the deer. So, too, some of our English miners carried out greyhounds to hunt the hares in Mexico. The air on that elevated platform, nine thousand feet above the level of the sea, is so rare that the mercury stands at nineteen inches generally, and the dogs were soon exhausted, with running in such an atmosphere; but their whelps are not at all incommoded by it, and hunt as easily as the dogs of the country.

Respecting the elephant, extraordinary accounts are told by military men who were in the Burmese war. They relate that when any extra task is to be performed by them, some favorite dainty is held up beforehand, and the sagacious animal, comprehending the promise of reward, thus implied, exerts himself to earn it. This comes to the principle of barter, as near as may be.

GENERAL NOTE RESPECTING EVIDENCES OF DESIGN.

All the inquiries in which we have been engaged, lead to one conclusion, of great importance. Notwithstanding the progress which has been made in various sciences, the things which have been discovered and ascertained, bear an infinitely small proportion to those, of which we are still either wholly ignorant, or imperfectly and dubiously informed. In a vast variety of instances, design and intelligence have been traced—instances so well deserving to be called innumerable, that we are entitled to believe in contrivance as the universally prevailing rule, and we never hesitate so to conclude. But the mode and manner of the working is still, in a prodigious number of cases, concealed from us; and we are entitled to infer that numberless things which now seem irregular, that is, arranged according to no fixed rule, are, nevertheless, really disposed in an order, which we have not discovered, but which would, if we knew all, be as complete as that observed and traced in the cases known to us. Thus the regular working of bees is reducible to certain known rules; the figures formed by them are, in all their relations, familiar to mathematicians. The problems of maxima and minima, on the solution of which those operations proceed, may have parallels, in the case of other animals; it is not at all improbable, that the beaver forms his dike for protection against the water, upon some such principle, namely, of the form which is, better than any other conceivable form, calculated to oppose a solid resistance to the pressure of water.* It appears probable, that the works of spiders in concentric circles, and along their radii, are also regularly arranged in known figures, and upon similar principles. Many of the parts of plants, wear the semblance of regular and symmetrical curve lines, insomuch that a mathematician once presented a paper to the Royal Society, (on some propositions in the higher geometry,) which he entitled, from the form of the lines investigated, '*Fasciculus Florum Geometricorum.*' The orbits in which the heavenly bodies move, come manifestly within the same remark, still more certainly;

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* The base of the dike being 12, the top 3 feet thick, and the height 6 feet, the face is the side of a right-angled triangle, whose height is 8 feet; and if the materials were lighter than water in the proportion of 44 : 100, this construction would be the best one conceivable, to prevent the dam from turning round. But the form flatter than that which would best serve this purpose when the materials are heavier than water, is probably taken to prevent the dam from being shoved forward

for the forms of those paths, the relation of all their points to given straight lines, is in a great degree ascertained. But it seems very reasonable to conclude, that the small number of such regular figures, which the state of science in its various branches has as yet enabled us to trace, is as nothing, compared with those figures still so unknown to us, that in common speech we talk of them as *irregular*, while this is only a word, like chance, implying our own ignorance.

For the mathematical sciences, extraordinary as the progress already made may be reckoned, with regard to the difficulty of the subject, and the imperfect faculties of man, are most probably still in their infancy. Of the infinite variety of curve lines, we know but a very few with any particularity, to say nothing of our equal ignorance (connected with the former) of most of the laws of complex motion. In the parts of animal and vegetable bodies, especially of the larger kind, there are few symmetrical forms observed; greater convenience, in the former instance, at least, is evidently attained by other shapes. Yet there seems no reason to doubt that all the forms which we see, may be in reality perfectly regular, that is, that each outline is a curve, or portion of a curve, related to some axis, so that each of its parts shall bear the same relation to lines similarly drawn from it to this axis, which all its other points do. If we know little of algebraical curves, we know still less of those whose structure is not expressible by the relations of straight lines and numbers, the class called mechanical or transcendental, the forms of some of which, are very extraordinary, but all whose points are related together by the same law. There is every reason to expect that the further progress of science will unfold to us much more of the principles upon which the forms of matter, both organic and inorganic, are disposed, so that the order pervading the system may be far more clearly perceived.

So of motion—In one most important branch, dynamics is still in its infancy; we know little or nothing of the minute motions by which the particles of matter are arranged, when bodies act chemically on each other. Even respecting the motions of fluids, so much studied, as electricity, and heat, (if it be a fluid,) and the operation of the magnetic influence, science is so imperfect, and our data from observation so scanty, that mathematical reasoning has, as yet, hardly ever been applied to the subject. It is the hope of men who reflect on these things, and it is probably the expectation of those who most deeply meditate upon them, that, in future times, a retrospect upon the fabric of our present knowledge, shall be the source of wonder and compassion—wonder at the advances made from such small beginnings—compassion for the narrow sphere within which our knowledge is confined;—and when the greater part of what we are now only able to believe regular and systematic, from analogy and conjecture, will have fallen into an order and an arrangement certainly known and distinctly perceived.

THE END.

GLOSSARY

OF THE MEDICAL TERMS, AND OTHER NOT-EASILY-UNDERSTOOD WORDS AND PHRASES.

Abdomen, the lower part or cavity of the belly ; in insects, the lower part of the animal, united to the corslet or breast by a thread.

Ab extra, from without.

Abided, an obsolete preterit of abide, now abode.

Accretion, increase in size or extent by natural growth.

Absorbents, vessels which carry any fluid into the blood.

Acetate, a combination of acetic acid, or vinegar, with some alkali or earth, as potash or lime.

Achromatic, colorless.

Acids, a class of chemical substances which are so called from their taste. They change vegetable blue colors to red. When they combine with alkalies, or the metallic oxides and earths, they form the compounds called salts. *Mineral acids* are those which are produced from a union of oxygen gas with mineral substances, as sulphur.

Acoustic, pertaining to the sense of hearing, or the doctrine of sounds.

Acoustics, the science of sounds, showing their nature and modifications.

Acoustic nerve, the nerve which conveys the sensation of sounds.

Adipocire, a soft, unctuous, or waxy substance, resembling spermaceti, formed from animal matter in its progress towards decomposition ; and so called, from *adeps*, fat, and *cera*, wax.

Adipose, fatty, containing fat.

Æneas, a Trojan prince, whose adventures are celebrated by the poet Virgil, in his poem called the Æneid.

Aeriform, having the form or nature of air.

Æther, or *Ether*, a thin volatile fluid, lighter than common air ; a fluid formed by the distillation of alcohol with an acid.

Affinity, the disposition which two or more substances have for uniting with each other.

Aide-de-camp, a military officer, acting as aid or assistant to the commanding general.

Ajutage, spout, tube fitted to the mouth of a vessel, jet of a fountain.

Alkali, (plural *alkalies*,) a substance that has the property of combining with, and neutralizing the properties of, acids, producing salts by the combination. Alkalies change the vegetable blues and purples to green, red to purple, and yellow to brown. *Caustic alkali*, an alkali deprived of its carbonic acid, being thereby rendered more caustic and violent in its operation. This term is usually applied to pure potash. *Fixed alkali*, an alkali that emits no characteristic smell, and cannot be volatilized or evaporated without great difficulty. Potash and soda are called the fixed alkalies. *Volatile alkali*, an elastic, transparent, colorless, and consequently invisible gas, known by the name of ammonia, or spirits of hartshorn.

Alluvial, relating to alluvium.

Alluvium, earth deposited by recent overflows of water. *Diluvium*, earth deposited by ancient overflows of water.

Alma mater, a nourishing mother, the name given by students to the college or seminary where they were educated.

Alopecias, the sea-fox.

Alpine, mountainous; a term derived from the mountains called the Alps, and often applied to other elevated regions.

Alveolar, containing sockets, hollow cells, or pits.

Ammonis, *Cornu Ammonis*, or *Ammonite*, a fossil shell, curled in circles like a ram's-horn. The name is derived from its resemblance to the curled rams'-horns on the temples of Jupiter Ammon.

Ampulla, (plural *ampullæ*,) the dilated or swelled portions of the semicircular canals just within the vestibule or inner cavity of the ear. See Cut 17, Vol. I. p. 114.

Anal, the term applied to those fins of fishes which are situated near the anus or vent.

Anastomosing, opening new communications between vessels, when the usual one is obstructed, or the opening of one vessel into another, as an artery into a vein, or a vein into another vein.

Anconæus, one of the muscles which extend the elbow joint.

Andrænidæ, one of the tribes or kinds of bees.

Aneurism, a dilatation or swelling of the coats of an artery.

Anhelation, breathing hard, or panting.

Anima, or *Animus*, the breath, the life, the thinking principle, the soul.

Anima mundi, the soul, or breath, or life, of the world.

Annular, in the form of a ring. *Annular ligament*, a ligament or band in the shape of a ring.

Annuli, rings; the muscular fibres which surround the bodies of some animals like rings, are so called.

Anoplotherium, (plural *anoplotheria*,) a class of animals without tusks, from a Greek word, meaning unarmed.

Antagonist muscles, those muscles of the body which act in opposition to each other.

Antelope, or *Gazelle*, a beautiful animal found in Asia and Africa. It is something like the roebuck and goat, and has the most beautiful eye of any animal in the world.

Antennæ, feelers; the horns or organs of touch situated near the mouths of insects. By some they are supposed to be organs of hearing.

Anthracotherium, (plural *anthracotheria*,) a class of fossil animals found in the coal strata of the Alps and Appenines, and so called from two Greek words, meaning coal and wild beast.

Anther, (plural *anthers* and *antheræ*,) that part of the stamen of a flower which contains the pollen or farina, a sort of mealy powder or dust, which is necessary to the perfecting of the flower.

Antler, a branch of a horn. *Antlers*, the branching horns of the stag.

Aorta, the main artery of the body, leading from the heart.

Apical, the top part, or apex.

Apidæ, one of the tribes or kinds of bees.

Apophysis, (plural *apophyses*,) the projecting soft end or protuberance of a bone.

Appetency, a desire or propensity; the disposition of organized bodies to select particular forms, and imbibe such portions of matter as may serve to nourish and support them.

A priori, from the former, in the first instance, from cause to effect.

Apterous, unwinged, without wings.

Aquafortis, literally, strong water, a name applied to nitric acid.

Aquatic, growing in the water or watery places.

Aqueous, watery. *Aqueous humor*, the watery or outer humor of the eye.

Arc, part of a circle or curve.

Archdeacon, an officer in the Church of England next in rank to the Bishop, for whom he acts on many occasions. He has a superintendence over other clergymen in his district.

Aristarchus, a celebrated grammarian, of the Island of Samos, who died, B. C. 157. Also an astronomer of the same Island, who first supposed that the earth turned on its own axis and revolved round the sun.

Aristomachus, the father of the three persons called Heraclidæ, who conquered the Peloponnesus, or the southern part of Greece, now called the Morea. Also the name of a ruler of Argos, who laid aside his sovereign power at the request of Aratus.

Armadillo, a quadruped found in the West Indies and Brazil, having a snout like a pig, feet like a hedgehog, a tail like a lizard, and the whole body covered with a thick shell, composed of plates or scales overlapping each other.

Aroma, the odorous principle which produces the fragrance peculiar to some plants and flowers.

Artery, a hollow tube or vessel, which conveys the blood from the heart to different parts of the body.

Articulata, the class of articulated or jointed animals.

Assizes, the session of a particular court in England, called the assize.

Astragalus, or *Talus*, the ankle bone ; the first bone of the foot, on which the tibia, one of the bones of the leg, rests.

Atlas, the uppermost vertebra of the spine or back-bone, the first bone of the neck.

Aura, a gentle breeze, or current of air ; sometimes used to denote the exhalation from a body, as the effluvia, odor, aroma, &c.

Auditory nerve, the same as the acoustic nerve. *Auditory tube*, the tube or passage of the ear, through which sound is conveyed.

Auricle, that part of the ear which is prominent from the head.

Auricles of the heart, the uppermost cavities, or those at the base of the heart, so called from their supposed resemblance to the ear.

The lower cavities are called the ventricles ; thus the heart is divided into a right auricle and ventricle, and a left auricle and ventricle. The auricles are membranous, but contain some muscular fibres which enable them alternately to contract and dilate with the ventricles, and thus force the blood onward.

Auroch, an animal of the ox kind, like the bison or buffalo, but without a hunch on its back.

Automaton, (plural *automata*,) a machine having a power of motion within itself.

Automatic, mechanical, not voluntary, not depending upon the will.

Axes, (plural of *axis*,) the imaginary straight lines passing through the centres of the planetary bodies, and round which they revolve.

Axil, or *Axilla*, (plural *axils* and *axillæ*,) the armpit, a cavity under the arm or shoulder. In botany, the angle between a leaf and the stem, on the upper side.

Azote, or *Nitrogen*, an invisible aeriform substance, or gas, which composes four fifths of the atmosphere, and is a constituent part of nitric acid, ammonia, &c.

Babyroussa, the Indian hog, found in Celebes and other places in India.

Bachelor, one who has taken the first degree in the liberal arts at the university.

Barometer, an instrument for measuring the weight of the air.

Bejuco, an Eastern plant—the cissus latifolia, which twines around various trees, and its leaves sometimes contain a quantity of water.

Biceps, two-headed, applied to such muscles as have two distinct origins or heads.

Biennial, happening in, or lasting, two years.

Bile, the gall, a bitter fluid secreted in the liver.

Bill-scale, a small protuberance on the upper mandible or bill of birds, before they are hatched, and with which they chip the egg so as to enable them to leave the shell.

Bison, a variety of the wild ox, with a hunch on its back, and a long mane.

Bivalve, a shell with two valves, or in two pieces connected by a ligament or hinge.

Bolt-ropes, ropes to which the edges or skirts of a vessel's sails are secured, to strengthen, and prevent them from rending. That portion which is on the perpendicular parts of the sail, is called the *leech-rope*, that at the bottom, the *foot-rope*, and that at the top, the *head-rope*.

Brachiæus, or *brachial*, belonging to the arm. *Brachiæus muscles*, two muscles moving the arm. *B. externus*, that which extends the fore-arm. *B. internus*, that which bends the fore-arm.

Branchiæ, the gills of fishes.

Breakwater, a dam or dike formed in a river or other stream, to break the force of the water.

Brevis, short ; applied to distinguish parts from others from which they differ only in length.

Buccinator, the principal muscle of the cheek, called also the *trum-*

peter's muscle, because it compresses the cheeks when they are distended, and forces the breath into the trumpet.

Burr, or *Pearl*, a circlet of tubercles at the root of a deer's horn, near the scull.

Cad-bait, or *Cadew worm*, see *Phryganea*.

Cæcum, or *blind gut*, from *cæcus*, blind, the first portion of the large intestine, so called from its being perforated at one end only.

Cæteris paribus, all other things being equal, or the circumstances being the same in each case.

Calcareous, consisting of lime, or partaking of the nature of lime.

Calculus, a department of mathematics—the science of fluxions. There are different kinds or branches of this science, as the *Differential Calculus*, the *Calculus* of *Variations*, &c.

Callow, destitute of feathers, unfledged, naked like a young bird.

Caloric, heat.

Calorific, heat-making.

Calyx, the flower-cup, the outermost and lower portion of the flower, generally of a green color.

Camelidæ, the tribe or family to which the camel belongs.

Camera Obscura, literally, a darkened chamber; the name of an optical instrument, by which the images of external objects, received through a double convex glass, are shown distinctly and in their proper colors, on the wall of, or on a table in, a darkened room.

Cancellated, crossbarred, having a reticulated or net-like structure.

Canine, having the nature of a dog. *Canine teeth*, the eye-teeth, two sharp-pointed teeth, so called from their resemblance to the teeth of dogs.

Canon, a law of the Church. Also a dignitary or officer in a cathedral church. *Canonry*, the office of a canon.

Capillary, fine, hair-like.

Capsule, that kind of hollow seed-vessel, which becomes dry and opens when ripe.

Carbon, pure coal.

Carbonate, a salt formed by the union of carbonic acid with some alkali, earth, or metal, as soda, lime, iron, &c.

Carbonic, having the nature of, or obtained from, carbon.

Cardia, the orifice or opening by which the food enters the stomach.

Cardiac, relating to the heart, acting upon the heart through the medium of the stomach, cordial, strengthening, cheering. It sometimes refers to the upper orifice of the stomach.

Cardium, the heart.

Carnivora, flesh-eaters. *Carnivorous*, feeding or living upon flesh.

Carotid arteries, those which supply the head with blood, situated one on each side of the windpipe.

Cartilage, gristle. *Cartilaginous*, gristly, consisting of, or formed from, gristle.

Caruncle, a small fleshy excrescence in the angle or corner of each eye next the nose.

To *Cast a horse*, to throw him suddenly on his back by a rope passed round his neck and legs so as to render him immoveable.

Caudal, relating to the tail.

Caul, *Omentum*, or *Epiploon*, a fatty membrane in the abdomen, which covers the intestines.

Caustic, burning ; any substance which, when applied to living animals, acts by burning the part to a hard crust.

Caustic alkali, see *Alkali.*

Cellular, consisting of cells.

Cement of the teeth, see *Crusta petrosa.*

Centipede, (hundred feet,) an insect which is so called from its having *many* feet, though not so many as a hundred. In our country, insects of this genus are seldom more than an inch long ; but in tropical climates, they are sometimes eighteen inches or more in length. *Millepedes* (thousand feet) derive their name also from their *many* feet, though they have but fourteen. The common woodlouse belongs to this class.

Centrifugal, having a tendency from the centre.

Centripetal, having a tendency towards the centre.

Cerate, (from *cera*, wax,) an ointment or salve composed of wax, oil, and other ingredients.

Cereal, relating to corn. Cereal plants are the several kinds of grain.

Cerebral, relating to the brain.

Cerebral nervous, relating to the nerves of the brain.

Cetacea, the whale tribe. *Cetaceous*, belonging to the whale kind.

Chemical, relating to chemistry. *Semi-chemical*, half chemical.

Chord, the string of a musical instrument ; a straight line drawn from one part of a curve to another.

Chrysalis, (plural *chrysalids* and *chrysalides*,) the state into which an insect passes from the caterpillar or reptile form, previously to its becoming a butterfly, or moth, &c.

Chyle, a white juice, formed from the chyme, and consisting of the finer and more nutritious parts of the food. It is afterwards converted into blood.

Chylification, or *Chylifaction*, the act of forming chyle.

Chyme, the result of the first process which food undergoes in the stomach, previously to its being converted into chyle.

Chymification, or *Chymifaction*, the act of forming chyme.

Cicatrix, a scar.

Circumscription, the termination, limits, or boundary of a body.

Cissus latifolia, an Eastern plant, which twines round various trees, and furnishes a supply of fresh water, when cut.

Class, *Order*, *Genus*, *Species*, *Family*, &c. In Natural History, animals, plants, minerals, &c., are arranged in different divisions, for convenience in systematizing them. The objects are first arranged in Classes, each Class is divided into Orders, each Order into Genera, each Genus into Species, and each Genus or Species sometimes into Subgenera or Subspecies. The term Family is sometimes used instead of Genus, and objects are often arranged in Families.

Clavicle, the collar-bone.

Cletch, or *Covey*, a young brood, as of chickens.

Coatimondi, or *Coati*, a species of animal inhabiting the woods of South America, resembling the racoon, though smaller, but with longer body and neck, shorter fur, and smaller eyes. Its upper jaw is an inch or an inch and a half longer than the lower one, and its snout, which is moveable in every direction, turns up at the point. Ray gives the name Coati to the racoon, and some authors have considered it a species of fox.

Cochlea, a snail, a snail shell, a cavity of the ear, resembling the shell of a snail. See Cut, Vol. I. p. 114, F.

Cocoon, the oval ball or case of silk spun by the silkworm, for a covering while it lies in the chrysalis state.

Cognate, of the same family.

Colchicum autumnale, the common meadow saffron.

Collectanea, a miscellaneous collection, gathered fragments.

Colon, the greater portion of the large intestine.

Colorific, color-making.

Columnæ carneæ, fleshy pillars or columns in the heart.

Comminuted, broken into small pieces.

Compages, a system or structure of several parts united, a suture, or joint.

Conatus, attempt, effort, endeavor, exertion.

Concentrate, to free from extraneous matter, to increase the strength of fluids by evaporating part of their water.

Concentration, the act of concentrating.

Concentric, having the same centre.

Concha, a shell ; the external ear, which is shaped like a shell.

Concoction, a digestion, alteration of the food in the process of digestion.

Concredited, intrusted.

Concrete, united in growth.

Conduit-pipe, a pipe for the conveyance of liquor.

Condyles, protuberances on the ends of bones.

Congeners, animals belonging to the same natural order.

Congeries, a collection of several bodies in one mass.

Congruous, consistent, agreeable to.

Conical, having the form of a cone.

Connate, produced or born together, having origin at the same time, and from the same cause.

Contractile, having the power of contracting or shortening.

Converge, to approach together.

Convolution, a turning, rolling, or winding ; the spiral windings of a snail's shell are called convolutions.

Coprolites, the excrements of animals turned to stone.

Copse, or *Coppice*, a small wood or forest, consisting mostly of underwood or brush-wood.

Cordæ tendineæ, or *chorda tendinea*, the cord-like and tendinous substances connecting the fleshy pillars of the ventricles of the heart to the valves of the auricles.

Corking-pin, a large-sized pin.

Cornea, the transparent coat in the front part of the eye.

Cornu, a horn. *Cornu Ammonis*, horn of Ammon, a name applied to the cortical, or outer part of the brain, and also to the petrified shells called Ammonites, from a resemblance to ornaments looking like rams'-horns, on the pillars of the temples of Jupiter Ammon.

Corolla, (plural *corollæ*,) the various-colored leaves or petals of a flower.

Corslet, that part of insects which answers to the breast of other animals.

Coterie, a friendly party, an assembly, a society, a club.

Cotyledons, the fleshy parts of a seed, the lobes; the two halves of a bean are its lobes, or cotyledons.

Covey, or *Cletch*, a young brood, as of chickens.

Cow-tree, a South American tree, which yields a delicious and nutritive milk, on its trunk being pierced. It grows in the most parched soils, and where rain is unknown for half the year.

Crag, a broken, pointed rock; a provincial name for a particular kind of rock found in different parts of England, composed of sandstone and shells.

Cranium, the scull or bony covering of the brain.

Craw, or *crop*, the stomach of a bird.

Cretaceous, formed, or consisting of, chalk, or of the same chemical composition with chalk, as the shells of oysters, &c.

Crista, the keel or central spine of the breast-bone of a bird.

Cristi galli, cock's-comb, an eminence on one of the bones at the base of the scull, which derives its name from its form. Also the name of the cock's-comb oyster.

Crocus, a genus of plants, of which saffron is a species.

Crop, see *Craw*.

Crustacea, the class of animals covered with a jointed and crust-like shell, as the crab or lobster.

Crustaceans, the animals of the foregoing class.

Crustaceous, having a jointed crust.

Crusta petrosa, one of the substances of which the teeth are composed, called by Cuvier, *cement*.

Crystalline, resembling crystal, pure, clear, pellucid, transparent.

Crystalline humor or *lens*, the pellucid or transparent humor of the eye.

Cubes, figures having six equal sides, like dice.

Cubit, or *Cubitus*, the fore-arm, or bone of the arm from the elbow to the wrist.

Cubital, relating to the cubit or fore-arm.

Cud, the food which ruminating animals, such as the cow, chew at leisure, after they have done eating.

Cuscuta Europæa, the flax-vine, a species of climbing plants, which derive their nourishment from the trees round which they climb.

Cuticle, or scarf-skin, the outer skin, that which rises in a blister.

Cuticular, relating to the cuticle or outer skin.

Cuttle-fish, or *Sepia*, a sea-fish, furnished with many suckers and holders, for securing its prey. When pursued, it discharges a black liquor which darkens the water, and thus facilitates its escape. This liquor is used in the composition of Indian ink.

Decarbonize, to deprive of carbon.

Deciduous, falling off. *Deciduous teeth*, the milk-teeth, or first set, which fall out during childhood.

Decomposition, the separation of bodies into their constituent parts.

Deflected, turned aside from its course.

Deglutition, the act of swallowing.

Demosthenes, a celebrated Athenian orator and ruler.

Dentata, having teeth, the second vertebra of the neck, so called from its tooth-like process.

Dentated, toothed, notched. *Dentation*, the state of being notched.

Depressor, a muscle which draws down or depresses the part to which it is attached.

Despumation, clarification, the act of throwing off extraneous matter in froth at the surface.

Descartes, an eminent French philosopher and mathematician, who died A. D. 1650. He extended the limits of geometry, as far beyond where he found them, as Newton did after him. He first taught the application of algebra to geometry.

Diagonal, in an angular direction, a line drawn from one angle to another of a square figure, dividing it into two equal parts.

Diaphragm, a partition, the midriff, a muscular partition which is stretched completely across the cavity of the body like a curtain, separating the chest from the belly.

Digastric, having a double belly, the muscle which moves the lower jaw downwards and backwards. See Vol. I. p. 227, Cut 44, A.

Diluvial, relating to diluvium.

Diluvium, see *Alluvium.*

Dinotherium, the name of an enormous fossil animal, allied to the tapir, the remains of which were found in Germany, near the Rhine, in Hesse Darmstadt.

Dionæa muscipula, an extraordinary American plant, called also Venus's fly-trap.

Dioptric, assisting the sight in the view of distant objects, affording a medium for the sight, relating to that branch of the science of optics, which treats of the refractions of light passing through different transparent substances.

Dispersion of rays of light, the divergence or separation of the different colored rays in refraction.

Diverge, to proceed from the same point, in different directions, like lines proceeding from a common centre, and constantly growing further apart. *Divergence*, the act of diverging.

Dorsal, belonging to the back.

Dorsum, the back ; the back of the tongue.

Dromedary, the Arabian camel.

Duct, a tube, canal, channel, or passage, for any fluid in the body.

Ductus arteriosus, a duct or artery-like canal, found only in the fœtus or very young children, which conveys the blood from the pulmonary arteries to the aorta, without passing through the lungs. It is closed up, soon after birth.

Ductus communis, *D. cysticus*, and *D. hepaticus.* The ducts or canals which convey the bile from the liver, are called the *biliary ducts;* these terminate in one trunk or canal called the *hepatic duct;*

this unites with the *cystic duct*, (which conveys bile from the gall-bladder,) and both form the *common duct*, or *ductus communis*, which terminates in the intestinal canal.

Duodenum, the first of the small intestines, being the next to the stomach, and receiving the food from it.

Duplicature, a doubling, or fold, of a membrane or vessel.

Dura mater, one of the membranes which enclose the brain, and which adheres strongly to the internal surface of the scull.

Ear-shot, hearing distance.

Ear-trumpet, an apparatus for conveying sounds to the ears of a deaf person.

Eccentricity, deviation from a centre, having a centre different from that of another circle.

Edentate, toothless, deprived of teeth.

Effectuate, to effect, to accomplish, to achieve, to fulfil.

Effervescence, a commotion, like boiling, in the parts of any substance, caused by the introduction of some exciting matter, and the escape of a gaseous substance, as is seen when an acid is poured upon limestone.

Effete, worn out with age, lifeless, barren.

Efflorescence, a redness of the skin, an eruption, the formation of a dry powder on the surface of any body, the time of flowering of plants.

Effluvium, (plural *effluvia*,) minute and often invisible particles perpetually flowing out of mixed bodies in the form of vapors, as smoke, steam, perspiration, odor of plants, &c. &c.

e. g., the first letters of the Latin words *exempli gratia*, meaning, for example.

Elements, the first principles, or simple constituent parts of bodies.

Elytron, (plural *elytra*,) an external, hard, scaly wing of an insect, such as the beetle.

Embryo, or *embryon*, the germ of a plant, or animal, so called from a Greek word signifying to bud forth.

Emys, a genus of fresh-water tortoises.

Encyclopédie, a French work treating of all branches of knowledge, projected by Diderot, a celebrated French poet, and writer on geometry, metaphysics, ethics, &c., who died in 1784. He was assisted in its preparation by several learned individuals, who are designated in French literature as the Encyclopedists.

Entomologist, one who pursues the study of entomology, or the history of insects.

Eocene, dawning, the earliest division of the tertiary formation of geologists.

Ephemeron, (plural *ephemera*,) an insect of a day.

Epicurean philosophy, the doctrines of Epicurus, a celebrated ancient philosopher, who taught that the universe originally consisted of atoms of various forms, sizes, and weights, which were dispersed at random through the immensity of space, and, by their numberless combinations and intervolutions, formed bodies and beings of all kinds. "He also taught that the greatest good consists in a happiness, springing, not from sensual gratification or vicious pleasures, but from virtue, and consisting in the peace and harmony of the soul with itself. He recommended wisdom, moderation, temperance, seclusion from political affairs, gentleness, forbearance towards the self-love of men, firmness of soul, the enjoyment of decent pleasures, (so far as it does not incapacitate us for new pleasures,) and contempt of life. Freedom from pain he regarded as desirable, but, at the same time, he bore with fortitude the most excruciating pains of body. Although he distinctly showed the meaning of his doctrines by his own exemplary life, yet they have been often misunderstood or misrepresented. Thus an *Epicurean*, according to the *perverted* meaning of the word, is one who is devoted to sensual enjoyments, particularly those of the table.''

Epiglottis, a cartilaginous or gristly valve, covering the glottis, or opening of the windpipe, and preventing food and other articles from falling into the windpipe.

Epiploon, see *Caul.*

Equilibre, or *Equilibrium*, equipoise, or equality of powers, balance, or weight.

Equipollence, or *Equipollency*, equality of force and power. *Equipollent*, having equal force or power, equivalent.

Eruca labra, a species of aquatic caterpillar.

Ether, see *Æther*.

Eustachian tube, the tube which forms the communication between the throat and the tympanum or drum of the ear, to preserve the equilibrium of the air, so called from its discoverer, *Eustachius*.

Evagation, the act of wandering, a roving or rambling, deviation from an appointed course, an excursion.

Evaporation, dissipation of fluids by heat.

Ex hypothesi, according to the hypothesis.

Exility, slenderness, smallness, thinness.

Exsiccation, act of drying, evaporation of moisture, dryness.

Extensor, a muscle which serves to extend or straighten any part of the body.

Extra, without, beyond, excess.

Extuberance, a swelling or rising of the flesh, a standing out, a protuberance, a knob or swelling of the body.

Exuvia, (plural *exuviæ*,) the slough, or cast-off skin, shell, or other covering of an animal.

Fæcal, containing or consisting of fæces or excrement.

Fæces, excrement.

Fahrenheit, a celebrated natural philosopher, born at Dantzic, A. D. 1686. He was eminent for his great improvements in the construction of the thermometer, an instrument used to ascertain the temperature of the air, liquids, and other bodies. The inventor's name is sometimes used for the instrument.

Family, see *Class*.

Farina, in botany, it means the pollen, or fine fertilizing dust or powder contained in the anthers of flowers.

Farrow, a litter of pigs, to bring forth, applied only to swine.

Fasciculus, a small bundle.

Fascine, (plural *fascines*,) a bundle of fagots, or small branches of trees, or sticks of wood, bound together, for filling ditches, &c.

Fecula, starch.

Fecundation, the act of making fruitful or prolific.

Felis, a genus of quadrupeds of a ferocious character, distinguished by their sharp and formidable claws, which are lodged in a sheath, and are capable of being extended or drawn in at pleasure. There are upwards of twenty species in this genus, among which are, the lion, tiger, panther, cat, &c.

Femur, the thigh.

Fenestra, a window, entry, or hole. *Fenestra ovalis*, an oval opening between the cavity of the tympanum or drum and the vestibule or inner cavity of the ear. It is shut by the stapes. *Fenestra rotunda*, a round opening leading from the tympanum to the cochlea of the ear. See Cut 17, Vol. I. p. 114.

Fermentation, a commotion or effervescence among the particles of vegetable matter, in certain circumstances, usually caused by the operation of acid matter and heat, and accompanied with the extrication of gas and heat.

Fibula, the small long bone extending from the knee to the ankle. See Cut 36, Vol. I. p. 194.

Filament, the thread-like stalk of the stamen of a plant, which supports the anther.

Fixed alkali, see *Alkali*.

Flexors, those muscles which serve to bend the parts to which they are attached.

Flexure, a winding or bending.

Floating Academy, a cant term for thieves, who in England are taught to steal when young, by those who are older.

Florum, flowers, relating to flowers.

Fluate, a kind of salt formed by the union of fluoric acid and some other substance. *Fluate of lime*, the combination of lime with fluoric acid, known as fluor spar, of which many chimney and other ornaments are made. *Fluor* means that which melts easily.

Fluxions, that branch of mathematics, which treats of the analysis of infinitely small quantities, showing the velocity with which they increase or decrease.

Focus, (plural *focuses* and *foci*,) a central point, or point of concentration; the point where all the rays of light meet, after passing through a lens; the point in an oval figure where the rays, reflected from all parts of the curves, meet.

Fœtus, the young of an animal after it is perfectly formed, and before birth, as the chick in the egg. *Fœtal*, relating to a fœtus.

Foramen, a small opening. *Foramen magnum*, the hole in the base of the scull, through which the spinal marrow descends from the brain into the spine. *Foramen ovale*, an oval hole or opening between the two ventricles of the heart, permitting the passage of blood from one to the other. It is found (except in rare cases) in the fœtus only, and is usually closed after birth.

Fossils, animal and vegetable substances, which have lain long in the earth, or in rocks, and have thereby become petrified, or of a stony hardness.

Fraying, rubbing ; the removal, by rubbing, of the outer cuticle, or velvet, of a stag's horn. *Fraying-post*, the tree against which the animal rubs off this cuticle.

Frontal, pertaining to the front. *Frontal bone*, the front bone of the scull which forms the forehead. See Cut 38, Vol. I. p. 263.

Fructification, the act of rendering productive of fruit. Also, the flower and fruit with their parts. *Fructify*, to make fruitful.

Fruitage, fruit, collectively taken ; various fruits ; the produce of a plant.

Fusee, the conical wheel in a watch, round which the chain is wound. It is made conical, that, as the strength of the spring decreases, by unbending, the chain, passing round a larger circumference, may not exert so much force upon the spring.

Gall, the bile. *Gall-bladder*, a receptacle for the bile. *Gall-duct*, the canal which conveys the bile into the intestines. See *Ductus Communis*, &c.

Gallinaceous, birds which belong to the order called *Gallinea*, living generally upon grains, or the seeds of plants, and having short powers of flight. Such are our common domestic fowls, the turkey, peacock, pheasant, &c.

Galvanic, relating to *Galvanism*, a branch of the science of electricity first discovered by Galvani, a professor of Bologna, whence its name. The electricity is not developed by the aid of friction, but by a chemical action which takes place between certain bodies, such as plates of different metals, separated by moist pieces of cloth or an acid mixture.

Ganglion, a knot found in the course of a nerve, particularly where it sends out or receives a branch, or where two nerves join together. It is a constituent portion of the system, and not the result of disease. *Ganglionic*, relating to ganglions.

Gavial, an animal belonging to the crocodile family.

Gas, an elastic aerial fluid. *Gaseous*, in the form of gas.

Gastric, relating to the stomach. *Gastric juice*, the fluid which dissolves the food in the stomach. It is limpid, like water, of a saltish taste, and without odor.

Gazelle, see *Antelope*.

Gelatin, gelly, a transparent animal substance, soluble in water but not in alcohol. *Gelatinous*, having the nature of gelly.

Genera, see *Class*.

Geometricorum, things from geometry, geometrical truths.

Geosaurus, a fossil animal, of the Saurian or Lizard order, so named by Cuvier.

Germ, the origin or first principle, the seed-bud of a plant, the lower part of the pistil, which afterwards becomes the fruit.

Germination, the act of sprouting, the first beginning of vegetation in a seed or plant.

Gestation, the act of carrying the young within the body of the parent, before birth, whether in the state of the egg, or the living fœtus.

Giganteum, gigantic.

Gillaroo trout, a name given to certain trout found in the Irish lakes. The name is by some supposed to be a corruption of Killaloe, a town near which they are caught; by others, it is thought to be derived from the Welsh *cylla*, stomach, and the Irish *ruadh*, strong, that is, strong stomach, alluding to the thickness of the coats of the stomach.

Ginglymus, a hinge-joint.

Glands, portions of the human body, of a round shape, composed of blood-vessels, nerves, and absorbents, and destined for the secretion or alteration of certain fluids.

Glottis, the upper opening of the windpipe, in the back of the throat.

Gluten, glue, that part of the blood which gives firmness to its texture. By gluten, is also meant a tenacious, ductile substance, procured from most kinds of grain, as wheat, by repeated washings of the flour in large quantities of water, which dissolves the fecula or starch, and leaves the gluten behind. It is the most nutritious part of vegetables.

Glutton, the carcajou, a cunning, voracious animal, which inhabits Europe, Asia, and America, and which preys on the carcasses of hares, mice, &c.

Goniometer, an instrument to measure angles.

Gossamer spider, the field or flying spider as it is called, which spins a fine filmy web called gossamer, that is frequently seen floating in the air in clear weather.

Graminivorous, grass-eating, feeding or living on grass.

Granivorous, grain-eating, feeding or living upon grain and seeds.

Gravid, loaded or filled with, full, heavy, fruitful, pregnant, with young.

Gravitation, the act of tending to the centre, the pressure that a body, by force of its gravity, exerts on another under it.

Gravity, weight, heaviness, the force by which bodies are drawn towards the centre of the earth.

Gregarious, herding or flocking together, living together in herds or companies.

Groin, the angular curve made by the union or intersection of two arches. *Groining*, the construction of a ceiling with groined arches.

Gullet, the passage through which food passes from the mouth into the stomach.

Gulo, an animal of the Bear genus, called, by Buffon, glutton.

Gymnosophists, a sect of Indian philosophers, who always went unclothed and lived a solitary life.

Gypsum, plaster of Paris, sulphate of lime.

Halitus, a vapor, the breath.

Harlequin, a buffoon, one who plays tricks to please the multitude.

Harpies, fabulous monsters, said to have had the head of a woman, the body of a vulture, and their feet and fingers armed with sharp claws. They plundered Æneas, during his voyage towards Italy.

Haw, a gristly excrescence in the eye. The third eyelid in the horse is thus termed.

h. e., hoc est, that is.

Hemiplegia, a paralysis or palsy of one side of the body.

Herbivora, eaters of herbs and herbaceous plants in general.

Herbivorous, living or subsisting upon herbs and herbaceous plants, or rather upon vegetable substances in general. A term used in contradistinction to carnivorous.

Hexagon, a figure having six sides and six angles.

Hexagonal, having the form of a hexagon.

Himmaleh, a vast chain of mountains, the highest known in the world, situated in Asia, and separating the Chinese empire and Thibet from Hindostan and Independent Tartary. The highest point, which has been ascertained, is 26,862 feet above the level of the sea.

Hippopotamus, the river-horse.

Homologous, similar, proportional to each other, having the same relations and proportions.

Homo Diluvii testis, a human witness of the Deluge.

Hopper, a wooden trough through which grain passes to the mill-stones for grinding.

Humerus, the arm. See Cut 28, Vol. I. p. 162.

Humor, a general name for any fluid of the body except the blood. *Aqueous humor*, the very limpid or watery fluid which fills the chambers of the eye. *Crystalline* (or icy) *humor*, or *lens*, a pellucid body next to the aqueous humor and before the vitreous. *Vitreous* (or glassy) *humor*, a pellucid and beautifully transparent substance, which fills the whole bulb of the eye behind the crystalline lens.

Hyæna, a ferocious animal, found in Asia and Africa, nearly allied to the wolf and dog, which infests burying-grounds, and seizes whatever comes in its way. It also attacks flocks of sheep and other animals, and devours them with an insatiable and ravenous appetite.

Hybernacula, winter quarters of animals.

Hydra, the fresh-water polypus, an animal which multiplies on being divided, each part becoming a perfect animal. Its name is in allusion to a fabulous monster, with many heads, which infested the lake Lerna, in Greece. When one of its heads was cut off, it is said that two immediately grew up in its stead, unless fire was applied to the wound. It was destroyed by Hercules, who caused a burning iron to be applied to the wound, as soon as a head was cut off.

Hydraulic, relating to the science of *hydraulics*, which treats of the motions of fluids, particularly of water, and its conveyance, through pipes, to reservoirs, &c.

Hydrocantheri, a species of aquatic insects.

Hydrogen, one of the substances or constituents of which water is composed.

Hyperodons, a class of cetaceous animals.

Ichneumonidæ, the family of insects called ichneumons, a sort of fly which deposits its eggs in the bodies of other insects.

Ichthyosaurus, a fossil animal of the saurian or lizard tribe, but having the back and vertebræ of a fish.

Ignited, being raised to a high degree of heat, set on fire.

Iguana, an animal found in Africa and America, of the lizard class. It lives among the trees on the banks of streams, and its flesh is said to be a great delicacy.

Iguanodon, a fossil animal of the lizard tribe, so named by Cuvier, from its teeth bearing some resemblance to those of the Iguana.

Imago, the perfect state of insects.

Imbelle,peaceful, harmless.

Inception, beginning.

Inchoate, to begin, begun, commenced.

Incisive, cutting.

Incisors, the four front, or cutting, teeth.

Incus, an anvil, a bone of the ear, so named from its likeness to a smith's anvil. See Cuts 17, 18, 19, Vol. I. pp. 114, 116, 117.

Inertia, inertness, a property of all matter, which disposes it to remain in the state in which it may be, whether of rest or motion.

Infinitesimal, an indefinitely small quantity.

Inflexion, the act of bending or turning from a direct course; an extensive refraction of the rays of light, caused by the unequal thickness of the medium through which they are passed.

Infra, below.

Infusoria, an order of animalculæ, found in stagnant water, and not discoverable without the aid of a microscope.

Insectivorous, feeding or subsisting on insects.

Invertebral, or *invertebrated*, destitute of a vertebral column, or back-bone.

Iridescence, exhibition of colors like the iris or rainbow.

Iris, (plural *irides*,) the striped variegated circle in the eye, surrounding the pupil, so called from iris, the rainbow.

Jet d'eau, an artificial fountain.

Jura, a chain of mountains, extending along the Rhine, being the continuation of the Savoy Alps, and forming part of the boundary between Switzerland and France.

Jurassic, relating to geological formations similar to those of the Jura Mountains.

Juxtaposition, in contact with, or near to, another person or thing.

Kangaroo, a singular animal found in New Holland, as large as a sheep, which leaps and eats like a squirrel, and is furnished with a bag or pouch in the abdomen, for the warmth and protection of its young.

Keel, the central spine of the breast-bone of birds.

Labium, (plural *labia*,) a lip. *Labiate*, having lips. Those flowers are called labiate, which gape open like the mouth of an animal, having an upper and lower lip, as sage, lavender, catmint, &c.

Labra, or *Labrus*, a genus of fish, including numerous species, some of which are of great beauty.

Labyrinth, a maze, a place full of intricate windings, that part of the internal ear which is behind the cavity of the tympanum. See Cut 17, Vol. I. p. 114.

Lacerta, a lizard, the tribe of lizard-like animals.

Lachryma, a tear. *Lachrymal*, relating to, or producing, the tears. *Lachrymal duct*, the canal which conveys the tears to the surface of the eye. *L. gland*, the gland which secretes or produces the tears. See Cut 15, Vol. I. p. 99. *Lachrymatory*, a vessel to contain tears.

Lacteal, milky, pertaining to milk. The *Lacteals* are small hair-like vessels opening upon the internal face of the intestines, absorbing the chyle, and conveying it through other vessels to the blood.

Lagomys, rat-hare, (from two Greek words having that meaning,) a genus of the order *rodentia*, or gnawing animals, discovered by Pallas, and hitherto found only in Siberia. The fossil remains of an unknown species of lagomys were found at Corsica, some time since.

Lamantin, a species of the walrus or sea-cow.

Lamella, a thin plate or edge. *Lamellated*, formed in thin plates.

Lamellicorn beetle, a species of beetle, so called from its lamellated horns.

Lamina, (plural *laminæ*,) a thin plate or layer, the lap of the ear. *Lamina spiralis*, a curiously-formed septum or partition, which divides the canal of the cochlea into two passages termed scala. It is partly bony, partly cartilaginous, and partly membranous.

Lamprey, a species of fish which adheres firmly to rocks and other bodies by the mouth. It is as slippery as, and shaped like, an eel.

Laniarii, the canine teeth of carnivorous animals, so called from a Latin word signifying tearing, because their use is to tear flesh.

Larva, (plural *larvæ*,) the worm-state, or first form of insects after they leave the egg.

Larynx, the upper part of the windpipe.

Latent, hidden, concealed, not visible.

Leeches, the edges or borders of a sail. *Leech-lines*, ropes fastened to the middle of the leeches of a sail, to haul it up to the yard. *Leech-rope*, that part of the bolt-rope to which the border or edge of a sail is sewed.

Leguminous, pod-bearing. Leguminous plants are those, the seeds of which are enclosed in pods, as peas, beans, tamarinds, &c.

Lens, a piece of glass or other transparent substance, used to collect the rays of light into a focus or point, or disperse them, according to the form of the lens. A concave lens disperses the rays, a convex one brings them to a point. *Lens of the eye*, see *Crystalline lens*, or *humor*.

Levator, a muscle serving to lift up the part to which it is attached. *Levator palpebræ superioris*, a muscle that raises the upper eyelid.

Levitation, lightness, buoyancy, the act of making a body more light or buoyant.

Lias, an argillaceous or clayey limestone, probably so called from a corruption or provincial pronunciation of the word *layers*, as the strata are generally flat and regular, and in thin slabs or layers.

Libellula, the dragon-fly.

Ligament, a binding, an elastic and strong membrane, connecting the moveable bones. *Ligamentous*, binding, of the nature of a ligament. *Ligamenta subflava*, ligaments which run along the course of the spine. *Ligamentum nuchæ*, a strong ligament of the neck, which proceeds from one spinous process to another.

Ligneous, wooden, resembling wood.

Lignite, fossil wood.

Linnæus, a celebrated botanist, who first arranged Natural History into a regular system, which has been generally adopted, and is called by his name.

Liquor Morgagni, a fluid surrounding the crystalline lens of the eye; so called from Morgagni, a celebrated physician.

Lithophytes, according to the Linnæan system, are an order of aquatic worms, which form coral, madrepore, &c.

Llama, an animal of the camel kind, found in Peru and Chili. It has a hunch on the breast, soft hair, and a neighing voice.

Longus, long, applied to distinguish parts of the body differing from others only in length.

Lophiodon, a fossil animal, so named by Cuvier, on account of the hilly ridges or eminences of its teeth, from two Greek words meaning a small hill, eminence, or ridge, and a tooth.

Loranthaceæ, a natural order of plants, to which belongs the genus *Loranthus*, so called from two Greek words, signifying a strap or thong, and flower, in allusion to the long linear shape, and leathery substance, of the petals. This is a genus of parasitical shrubs, chiefly tropical, and many of them extremely beautiful. The American Loranthus has branches that are subdivided, leafy, smooth, pale green, and brittle, and bears red flowers. It climbs over the highest trees in Jamaica, its roots adhering firmly to the bark like the mistletoe.

Lubricate, to make smooth or slippery.

Lubricity, smoothness, slipperiness.

Lupous fish, the sea-wolf, a kind of fish that swallows its prey whole.

Lusus naturæ, a sport of Nature, a monster.

Luxation, dislocation of a bone, or putting it out of joint.

Lymph, a clear, limpid fluid, which is found in animal bodies, in what are called the lymphatic vessels. It soon congeals into a gelly or clot. It mixes with the chyle and with the blood.

Lymphatic, pertaining to lymph, enthusiastic. *Lymphatics*, small vessels in the bodies of animals containing or carrying lymph. *Lympheduct*, one of the lymphatic vessels.

Maceration, the act of making thin or lean by wearing away, the process of steeping substances in cold water, to soften them and extract their peculiar properties.

Malleus, a hammer or mallet, a bone of the ear, so called from its shape. See Cuts 17, 18, 19, Vol. I. pp. 114, 116, 117.

Mammilla, the breast.

Mammellated, studded with nipples, like a breast.

Mammæ, the breasts.

Mammalia, the first class of animals in the Linnæan system, comprehending such as suckle their young, so called from *mamma*, the breast.

Mammiferous, having breasts.

Mammillary, pertaining to the breast.

Mandible, the jaw of beasts, the bill of birds.

Manipulations, work by hand, manual operations.

Margrave, a German nobleman or prince, ranking between a count and a duke.

Marl, a sort of earth, composed of carbonate of lime and clay, useful for manure on some barren soils. *Marly*, having the nature of marl.

Marsupial, animals having pouches, like the kangaroo. So called from a Latin word signifying pouch or purse.

Marsupium, a purse-like muscle, in the eyes of birds, to draw the lens back.

Masseter, a strong muscle which closes the jaw in chewing.

Mastodon, an enormous fossil animal, so named by Cuvier, from the mammellated structure of the teeth, from two Greek words signifying breast and tooth.

Maxilla, (plural *maxillæ*,) the jaw.

Maxima and minima, greatest and least; terms employed to indicate the greatest and least number or quantity that can be attained in any given case. "In mathematics, where an extensive application is made of the notion of greatest and least, by the greatest or smallest value of a variable quantity is understood that value which is greater or smaller than any preceding or following one in the series of the values of this quantity, however near either may be taken to that greatest or least value. For example, let it be required to divide a number, 8, in such a manner that the product of the parts shall be a *maximum;* the method of *maximum and minimum* shows that the number must be divided into two equal parts, for 4 times 4 are 16, while 3 times 5 are only 15, twice 6 only twelve, &c., so that, according to the above definition, 16 is the *maximum* in the series of numbers successively obtained." "The problems which relate to the *maxima and minima* are considered among the most interesting in mathematics."

Mécanique Céleste, Celestial Mechanics, the title of a great work of La Place, a French astronomer, on the mechanism of the heavens.

Mediastinum, a fold of the membrane which separates the chest and its cavity into two parts.

Medium, (plural *media*,) the space or region through which a body in motion passes, or the substance through which it passes.

Medulla, marrow. *Medulla oblongata*, the beginning of the spinal marrow, or an extended portion of the brain. *Medullary*, like marrow.

Medusa, a sort of worms, which, causing a slight tingling and redness when touched, are denominated sea-nettles. Also a genus of marine animals which float like gelly in the water.

Megalonyx, a large fossil animal, so named by Cuvier from two Greek words signifying great and nail, on account of the size of his claws.

Megalosaurus, a large fossil animal of the saurian or lizard tribe.

Megatherium, (plural *megatheria*,) a large fossil animal, so named by Cuvier, from two Greek words signifying great and wild beast.

Melæna, the black vomit, a disease.

Membrane, a thin expanded substance, formed by elastic fibres, interwoven like those of a net, and so arranged as to allow of great pliability. *Membrana nictitans*, a thin membrane found covering the eyes of fishes and birds, to shield them from dust and excess of light. *Membrana tympani*, the membrane covering the cavity of the drum of the ear. *Membranous*, like a membrane.

Menstruum, (plural *menstrua*,) any liquid in which another body is dissolved.

Mesentery, a double fold of the membrane lining the abdomen, and covering the intestines, by which the latter are suspended, and are connected to the walls of the cavity. See Cut 59, Vol. I. p. 279.

Metacarpal, belonging to that part of the hand which is between the carpus, or wrist, and the fingers.

Metaphysician, one who is versed in metaphysics, or the science of the mind. *Metaphysical*, relating to metaphysics.

Metatarsal, belonging to that part of the foot between the tarsus, or instep, and the toes.

Microscope, an optical instrument which magnifies minute objects, so as to make them more distinct, or render visible what otherwise could not be seen.

Millepedes, see *Centipedes*.

Minerals, inorganic natural substances found upon or in the earth, such as earths, salts, metals, &c.

Mineral acid, an acid formed with some mineral substance.

Miocene, less recent, the division of the tertiary formation, between the *Eocene* and *Pliocene* divisions.

Mistletoe, a climbing parasitical plant, which derives its nourishment from the tree round which it climbs.

Mitral valves, the valves of the left ventricle of the heart, so called from a supposed resemblance to the mitre or conical cap of a bishop.

Mobility, capacity for motion.

Modiolus, the central column round which the canal of the cochlea (or spiral cavity) of the internal ear turns.

Mohammedan, a follower of Mohammed, or pertaining to the doctrines of that celebrated impostor, who was born at Mecca, in Arabia, A. D. 569, and died at Medina, in the same country, A. D. 632. He was the founder of a system of religious belief which is still adhered to by the Turks.

Molar teeth, the double teeth, or grinders, so called from a Latin word signifying a grindstone.

Mollusca, (plural *mollusca*,) the order of marine, naked, soft-bodied animals, not included in a shell, but furnished with limbs, as the cuttle-fish, &c.

Molluscous, belonging to, or of the nature of, the mollusca.

Monad, a microscopic aquatic animal, consisting simply of a very minute point or globule of matter.

Monitor, a genus of large lizards, so named from a popular belief that they give warning of the approach of crocodiles by a kind of whistling noise. Fossil remains of species much larger than any now existing have been found in Europe.

Monopetalous, one petalled flowers, those, the corolla of which consists of one petal only.

Morgagni liquor, see *Liquor Morgagni*.

Mosasaurus, a Saurian animal found at Maestricht, and so named from its character being intermediate between the Monitor and Iguana.

Mucilage, an aqueous solution of gum, one of the constituents of vegetables, a slimy substance which moistens and lubricates the joints and ligaments of animal bodies. *Mucilaginous*, gummy, slimy, ropy, partaking of the nature of mucilage.

Mucous, having the nature of mucus.

Mucus, a glutinous, sticky, thready, transparent fluid, of a salt savor, produced by different membranes of the body, and serving to protect the membranes and other internal parts against the action of the air, food, &c. The fluids of the mouth and nose are mucus.

Mytilus, the mussel, a bivalve shellfish. *Mytilus crista galli*, the cock's-comb oyster.

Myxine, a cartilaginous fish, called also the hag. It is said to enter the mouths of fishes, and totally devour every thing save the bones and skin.

Naïveté, candor, simplicity.

Nascent, beginning to exist or grow.

Nautilus, a species of shellfish that has the power of floating on the surface of the water, and, by extending a membrane attached to its arms, which serves for a sail, of propelling itself in the direction of the wind. It is said that mankind learned the art of navigation from this animal. This is frequently confounded with the Argonauta, which is the Paper Nautilus.

Nectary, the part of a flower that produces honey.

Nepenthes distillatoria, the Pitcher plant, *which see.*

Nephralgia, pain in the kidney. *Nephralgic*, pertaining to the kidney, from a Greek word signifying kidney.

Nervous, strong, vigorous, pertaining to the nerves, seated in or affecting the nerves.

Nictitating, winking, applied to the thin membrane which covers the eyes of fishes and birds, shielding them from dust, and excess of light.

Nigella, a genus of plants, of which the fennel-flower is a species. It derives its name from *niger*, black, on account of its black seeds.

Nitre, a salt formed by the union of the nitric acid with the vegetable alkali, (potash,) and commonly called saltpetre. It is the principal ingredient in the manufacture of gunpowder.

Nitric, composed of, or impregnated with, nitre. *Nitric acid*, a strong and powerful acid, composed of nitrogen and oxygen gases, and usually obtained by distilling nitre and sulphuric acid together.

Nitrous, pertaining to nitre, having the qualities of nitre. *Nitrous acid*, an acid somewhat similar to, but weaker than, nitric acid.

Nitrogen, or *Azote*, one of the constituent gases of which the atmosphere or common air is composed ; but by itself, it extinguishes flame, and destroys animal life.

Node, a centre, the point where the orbit of a planet intersects the ecliptic.

Nucleus, the kernel of a nut, the body round which any matter is collected, the body or head of a comet.

Nutation, a nodding, a moving of the body from one side to the other, a tremulous motion of the earth's axis.

Nymph, (plural *nymphæ*,) the pupa or chrysalis state of insects.

Oblate, flattened.

Occiput, the hinder part of the head.

Occipital bone, see C, in Cut 38, Vol. I. p. 203.

Œsophagus, the gullet, the tube or canal which conveys the food from the mouth to the stomach.

Œstrum, the gad-fly.

Omentum, see *Caul.*

Oolite, roe-stone or egg-stone, a variety of limestone, so called, from the small egg-like grains, like the roe of a fish, of which it is chiefly composed. *Oolitic*, resembling or pertaining to oolite.

Operculum, a lid, or door, the lid which covers the capsules of mosses ; also that which closes the mouth of a univalve shell.

Optic, relating to vision or sight. *Optic nerve*, a nerve proceeding from the brain to the eye.

Optimism, the doctrine that every thing in Nature is ordered for the best, or that the order of things in the universe is that best adapted to produce the most good.

Orbicularis, a circular muscle which surrounds any part like a ring, the muscles which shut the eyelids.

Orchestra, the place in a theatre appropriated to the musicians, the body of performers in the orchestra.

Order, see *Class.*

Organic remains, those animal and vegetable substances which are found in or upon the earth in a mineralized state.

Orrery, a machine to represent the motions of the heavenly bodies, so named in honor of the Earl of Orrery, for whom one of the first ones was constructed.

Os, a bone. *Os hyoides*, the bone which forms the basis and support of the tongue. It is named from its resemblance to the Greek letter *υ*, (*υ*, and *ειδος*, likeness.) *Os illii*, one of the bones which form the side of the pelvis, or lower part of the belly. *Os orbiculare*, a small round bone in the ear. It is situated between the long leg of the anvil and the stirrup. It is the smallest bone in the human body. This and the other small bones of the ear are represented in Cut 19, Vol. I. p. 117, in the following order, viz., 1, the malleus, 2, the incus, or anvil, 3, the os orbiculare, 4, the stapes or stirrup. They are also shown in their proper connexion in Cut 18, Vol. I. p. 116, and in their natural situation in Cut 17, Vol. I. p. 114. *Os petrosum*, the temporal bone, so called on account of its stony hardness. *Os pubis*, the bone which arches forward from the pelvis, and forms the lower part of the belly.

Oscillate, to vibrate, to swing, to move backwards and forwards.

Osseous, bony, resembling bone.

Ossian, the name of a celebrated poet, who flourished in the Highlands of Scotland, about A. D. 300.

Ossification, the act of turning to bone.

Osteology, a description of bones.

Ostrea, an oyster. *Ostrea spondylus*, the prickly oyster. *Ostrea crista galli*, the cock's-comb oyster.

Outriggers, strong beams fixed on the side of a ship, and projecting from it, in order to secure the masts, when the ship is careening, or lying on one side for repairs. This name is also applied to a small boom occasionally used in the tops, to thrust out the breast back stays, in order to increase the angle of tension, and thereby give additional security to the topmast.

Ova, eggs.

Ovary, the part of a bird or other animal where the eggs are formed or lodged.

Oviparous, egg-laying, bringing forth or bearing young by means of eggs.

Ovipositor, egg-depositor, the instrument by which an insect deposits its eggs in any substance.

Oxygen, vital air ; that portion of the atmospheric air, which supports life. It was called oxygen from two Greek words signifying to produce acid, from its power of giving acidity to compounds in which it predominates.

Pachydermata, animals with thick skins, as the elephant, hog, &c. *Pachydermatous*, thick-skinned.

Palæontology, the science which treats of fossil remains, both animal and vegetable. From three Greek words signifying a discourse on ancient beings.

Palæotherium, ancient wild beast, so called from two Greek words having that signification.

Palladium, something that affords defence, protection, safety, so called from a statue of the goddess Pallas, which was supposed to serve as a protection to the place where it was set up.

Palmated, having a palm like that of the hand ; web-footed.

Palo de vaca, the cow-tree of South America, a tree which yields a nutritive milk on being pierced.

Palpa, feelers.

Pancreas, a gland within the abdomen, just below and behind the stomach, and providing a fluid to assist digestion. In animals it is called the sweet-bread. *Pancreatic*, belonging to the pancreas.

Pangolin, a species of the genus Manis, inhabiting Guinea, China, and India, and known to Naturalists as the short-tailed Manis. It is a quadruped from six to eight feet long, including the tail ; its color is a pale yellow brown, and its surface glossy. The whole animal is covered with thick, strong, and large scales, which from their hardness are said to be capable of striking fire like a flint, hence in Bengal it has the name, "Thunderbolt animal."

Panorpa, a tribe of insects. The most common species is a longish-bodied fly of a moderate size, with four transparent wings, elegantly variegated with deep brown spots.

Papilionaceous, resembling butterflies ; those plants, the flowers of which resemble butterflies.

Papilla, (plural *papillæ*,) small projections like pimples on the surface of organs, as on the tongue, &c., which are the seats of sensation.

Parallelogram, a right-lined four-sided figure, the opposite sides of which are parallel and equal.

Parasite, a hanger-on, a flatterer, a plant that attaches itself to, and is nourished by, another plant, as the mistletoe. *Parasitical*, of the nature of a parasite.

Parietal, pertaining to or within a wall. *Parietal bones* of the scull, see A, Cut 38, Vol. I. p. 203.

Par excellence, by way of eminence.

Parotid gland, a gland situated under the ear. See A, Cut 52, Vol. I. p. 254.

Parturition, the act of bringing forth young.

Patella, the knee-pan.

Patronage, the right of presentation to a church or benefice.

Pax-wax, a stiff cartilage on the side of the neck.

Pearl, see *Burr*.

Pectoral, pertaining to the chest.

Pellets, little balls.

Pelvis, the lower part of the abdomen, or cavity of the belly.

Pent-house, a shed standing aslope from the main wall or building.

Penumbra, a partial shade on the outside or border of a perfect shade.

Percipient, perceiving, having the faculty of perception. *Perceptivity*, the power or faculty of perceiving.

Perennial, lasting a year, perpetual.

Peri, about.

Pericardium, the bag containing the heart.

Pericarpium, a seed-vessel.

Periosteum, the membrane which adheres to and closely invests the surface of bones.

Peristaltic, worm-like.

Peritoneum, a strong membrane which lines the abdomen and surrounds its contents.

Per se, by itself.

Petals, the flower-leaves, or leaves of the corollas of plants.

Phalangal, belonging to the small bones of the fingers and toes.

Pharynx, generally called the upper part of the gullet ; it is the cavity or muscular bag at the back part of the throat, which conveys the food from the mouth into the œsophagus.

Phases, the various appearances of a planet.

Phosphate, a salt formed by a combination of phosphoric acid with an earth, as lime, an alkali, as soda, or a metal, as lead.

Phosphoric acid, an acid formed by the combination of phosphorus and oxygen.

Phryganea, a genus of insects termed by Reaumur Papilionaceous, proceeding from aquatic larvæ, and bearing a considerable resemblance to the moth tribe. The flies are called *cadew* worms, and are often used as *bait* by anglers, whence the expression *cad-bait*.

Physsophora, the gelly-fish, soft animals which float in sheltered mouths of rivers or lakes.

Pigment, paint, a mucous substance found in the eye, that which gives the beautiful variety of color in the eye.

Pistil, that part of a flower, generally in the centre, composed of the germ, style, and stigma, which receives the pollen or fertilizing dust of the stamens.

Piston, a sucker, a moveable cylinder in the tube of a pump, steam-engine, or other machine, intended to take off by its motion the pressure of the air, or receive the impulse from steam.

Pitcher-plant, a plant that produces vessels having a resemblance to pitchers, which are generally filled with pure water. See Cut 93, Vol. II. p. 68.

Planetaria, machines to represent the motions and orbits of the planets.

Plantule, a little plant, applied to the part which first sprouts from the seed when it begins to grow. It refers to the same part with plumule.

Plesiosaurus, a fossil animal, so named on account of its near resemblance to a lizard, from two Greek words, signifying near and lizard.

Pleura, a membrane which lines the internal surface of the chest, and covers its contents.

Pliocene, less recent, the third or latest division of the tertiary formation of geologists.

Plumule, or *Plume*, the ascending part of a plant at its first germination.

Pneumatic, relating to the air or wind.

Pollen, the fertilizing dust of flowers, produced by the stamens, and falling upon the pistils, in order to render a flower capable of producing fruit or seed.

Polypus, a sea-fish, resembling the cuttle-fish ; also a fresh-water insect, so called from its having many arms or feet.

Postulatum, a demand, any fundamental principle in a science, that is taken for granted.

Posture-master, one that teaches or practises artificial postures of the body.

Prebend, the stipend which is received by a Prebendary in the Church of England, from the revenues of a collegiate church or cathedral. *Prebendary*, a clergyman attached to a cathedral or collegiate church, who enjoys a prebend, in consideration of his officiating, at times, in the church. *Prebendal house*, the house set apart for the residence of the Prebendary. *Prebendal stall*, a seat in a collegiate or cathedral church for the accommodation of a Prebendary.

Precipitate, (*red*,) Nitric oxide of mercury, a very active and corrosive medicine.

Preen, or *prin*, to trim the feathers.

Preferment, advancement to a higher office or station.

Prepollence, or *Prepollency*, prevalence.

Primordial, original.

Primum mobile, the first cause of motion, the main spring, the first impulse.

Prin, see *Preen*.

Principia, first principles, the title by which Newton's great work on the first principles of Mathematics and Natural Philosophy is usually known.

Prism, an oblong, solid, tri-lateral or three-sided body, the bases or ends of which are equal, parallel, and situated alike, and the sides parallelograms ; a solid glass in the form of a prism, much used in experimenting on the nature of light and colors. See Cut 8, Vol. I. p. 80.

Prismatic, formed by, resembling, or pertaining to, a prism. *Prismatic colors*, the different colors of light separated by a prism. *Prismatic spectrum*, the image or visible representation of the different-colored rays when passed through a prism and thrown on a wall.

Proboscis, the snout or trunk of an elephant or other animal, particularly that of an insect.

Process, a protuberance, or projecting part of a bone.

Prophylactic, preventive, defending from disease.

Proteosaurus, a fossil animal, supposed to partake of the nature of a proteus and saurian or lizard-like animal.

Proteus, an animalcule resembling a snail in substance and color. Mr. Baker, who discovered it, named it Proteus, on account of its various sudden transformations.

Pulmonary, belonging to, or affecting, the lungs. *Pulmonary artery*, an artery which passes through the lungs, being divided into several branches, which form a beautiful network on the air-vessels, and finally empty themselves into the left auricle of the heart.

Puncta, points, or small orifices. *Puncta lachrymalia*, minute openings or orifices at the inner edge of the lower eyelid, through which the tears enter the canal which transmits them to the nostrils. See Cut 15, Vol. I. p. 99.

Pupa, (plural *pupæ*,) the same as *Chrysalis*, which see.

Pylorus, the inferior aperture of the stomach, which opens into the intestines. So called from a Greek word signifying the guard of the entrance, because this guards, as it were, the entrance of the bowels. *Pyloric*, pertaining to the pylorus.

Pyrites, a mineral composed of sulphur and a metal. Iron Pyrites, is Sulphuret of Iron ; Copper Pyrites, Sulphuret of Copper.

Pythagoreans, disciples or followers of Pythagoras, a celebrated philosopher of Samos, who flourished about five hundred years before the Christian era.

Quadrumana, or *Quadrumanes*, animals having four hands, or limbs that correspond to hands, as the monkey. *Quadrumanous*, four-handed.

Quagga, an animal found in Southern Africa, and sometimes called the wild ass. It is marked with stripes or bands on the neck and back, somewhat like the zebra, with which it has often been confounded.

Quartz, a mineral composed of silex or silicious earth, with a small portion of alumine or alum earth, and carbonate of lime. Rock crystal, is quartz in its purest state.

Quasi, as it were, in a manner, as, just as, as if, about, nearly, almost.

Quietism, inaction, the doctrine of the quietists, who maintained that religion consists in the internal rest or recollection of the mind, employed in contemplating God, and submitting to his will.

Radicles, the little fibrous branches proceeding from the main root, and which are first sent out by a seed, when it begins to grow.

Radius, one of the bones of the fore-arm, (See Cut 28, Vol. I. p. 162,) the distance from the centre to the circumference of a circle. *Radii*, plural of radius, when used in the last sense.

Rationale, the solution of an hypothesis, phenomenon, opinion, &c., with the reasons assigned.

Recrements, dross, or other superfluous matter separated from that which is useful.

Recherches, researches, inquiries, examinations.

Reflection, the act of throwing back, a motion of the rays of light, by which, when they strike upon any body, they are thrown back, as from a mirror.

Refraction, a deviation from a straight course. When rays of light pass through a lens, or from one medium to another, as from air into water, and the reverse, instead of continuing on in a straight line, they are said to be refracted or bent out of their course.

Refrangible, capable of being refracted.

Regurgitate, to throw back, as from a deep or hollow place.

Reniform, kidney-shaped, from *Ren*, the kidney.

Renitency, resistance to pressure.

Republic, a commonwealth.

Resiliency, the act of rebounding, or leaping or springing back.

Retina, a very sensible and delicate nervous membrane at the back part of the eye, on which the images of objects are received. It is considered an expansion of the optic nerve.

Retrievers, a species of dog, so called from their being used to bring or find game that has been once started ; as partridges.

Reverted, reversed, turned back.

Reviviscence, renewal of life, return to life.

Rhinoceros, a large beast found in India, and the largest of all quadrupeds, except the elephant, having a horn in front, on his snout, and a very hard skin, full of wrinkles.

Rhomboid, an oblique four-sided figure, whose opposite sides and angles are equal.

Rictus, the extent of the mouth when opened widely, as in gaping.

Rodentia, or gnawers, the class of animals which gnaw their food, as the squirrel, rat, &c.

Rookery, a nursery of rooks, which are a sociable bird of the crow kind.

Ruminate, to chew over, to chew the cud. *Ruminant*, chewing the cud, applied to animals like the cow, ox, &c.

Sabine, of the character of the ancient Sabines, who are described as an austere and hardy race, of great simplicity and purity of manners. Their piety and primitive worth are celebrated, and they are said to have set an example of all that was noble and upright to the early patriots of Rome.

Sac, a bag, a cavity shaped like a bag.

Saliva, the fluid which moistens the mouth.

Sanguiferous, carrying blood. *Sanguification*, the process of making the blood.

Sapid, tasteful, affecting the taste.

Sartorius, or tailors' muscle, a muscle which serves to bend the leg inwards, and bring one leg across the other, as tailors do when sitting at their work.

Saurian, lizard-like. *Sauroid*, of the class of Saurians. *Saurus*, a lizard.

Scala, a ladder or staircase. *Scala cochlea*, *Scala tympani*, and *Scala vestibuli*, internal parts of the ear.

Scapula, the shoulder-blade.

Scarabæus, a beetle.

Schist, or *Schistus*, slate.

Secrete, to produce from the blood or its constituents, by means of the glands.

Secretion, the separation of one fluid from another, in an animal or vegetable, by means of the glands. *Secretory*, relating to the office of secretion.

Semi, half. *Semi-chemical*, half chemical. *Semi-lunaris*, in the shape of a half moon. *Semi-mechanical*, half mechanical. *Semi-membranosus*, a muscle of the thigh, which serves to bend the leg. *Semi-opaque*, half transparent. *Semi-rotary*, half rotary, a twist.

Sensorium, the seat or centre of sensations, to which all the impressions made upon the external organs of sense are transmitted, and where they are perceived.

Sentient, having the faculty of perceiving.

Sepia, the cuttle-fish.

Septum, (plural *septa*,) a partition. *Septum narium*, the partition between the nostrils.

Servitor, in the University of Oxford, a student who attends on another for his maintenance and learning; the same as a *sizer* at Cambridge.

Sibyl, an ancient prophetess and priestess of Apollo. There were ten celebrated ones, as at Delphi, Cumæ, &c. The one at Cumæ is said to have shown the Emperor Tarquin nine books, containing prophecies, demanding three hundred pieces of gold for them, which Tarquin refused to give. She then burnt three of them in his presence, and demanded the same sum for the remaining six, which he still refused. She then threw three more into the fire, demanding the same sum for the remaining three, which the king is said to have given. These three books were afterwards preserved as sacred.

Silex, a species of mineral, of which entire rocks are composed. Rock crystal and flint are mostly composed of this earth, which is called *Silicious* earth.

Silurian, a name given by Mr. Murchison to certain English rocks, because they may be best studied in that part of England and Wales, which was included in the ancient British kingdom of the *Silures*.

Sinus, an opening, a cavity, or depression, in a bone or other part.

Siphon, a pipe.

Sizer, see *Servitor*.

Snow-shoes, a large and light contrivance fitted to the feet, and covering a large surface, to enable a person to walk over snow without sinking in.

Solution, disruption, explanation, the operation of dissolving or melting in a fluid, the intimate combination or perfect union of solid bodies with fluids, so as to form a liquid, the parts of which will not separate on standing.

Sonorous, yielding sound.

Sounding-board, a board or structure with a flat surface, suspended over a pulpit, to prevent the voice from ascending, and to throw it off in a horizontal direction; the board which propagates the sound in an organ.

Species, see *Class*.

Spectrum. A ray of light, being let into a darkened room through a small aperture, and falling on a triangular glass prism, is considerably dilated, and will exhibit on the opposite wall an oblong image called a spectrum.

Sphenoid, a wedge-shaped bone ; the name of one of the bones at the base of the scull. See E, Cut 38, Vol. I. p. 203.

Spheroid, approaching the form of a sphere, but not perfectly spherical.

Spherule, a little sphere, a small hollow ball.

Sphincter, a circular muscle which shuts up or closes the aperture round which it is placed.

Spicula, (plural *spiculæ*,) a spine or sharp projection.

Spine, the back-bone, so called from the spine-like processes of the vertebræ. *Spinous*, full of spines, thorny.

Spissitude, thickness or density of soft substances.

Spleen, or *Milt*, a spongy viscus, of a livid, or dark black and blue, color, and generally of an oval form, situated on the left side of the body, between the eleventh and twelfth false ribs. (For the position of the ribs, see Cut 30, Vol. I. p. 178.) Its use is not known.

Sputa, the spittle or saliva, any kind of expectoration, or ejection of matter, from the lungs.

Stamen, (plural *stamens* and *stamina*,) in *weaving*, the warp, the thread, any thing made of threads. In *botany*, that part of a flower, on which the artificial classification is founded, consisting of the filament or stalk, and the anther, which contains the pollen, or fructifying powder.

Stapes, a stirrup, one of the bones of the ear, so called from its resemblance to a stirrup. See Cuts 17, 18, 19, Vol. I. pp. 114, 116, 118.

Sternum, the breast-bone.

Stigma, (plural *stigmas* and *stigmata*,) the summit or top of the pistil of a flower.

Stile, see *Style*.

Stoic, (*Stoical Philosophy*,) a sect founded by the philosopher Zeno, who taught as a duty, patience and resignation under trials, and an indifference to pain and suffering. His instructions were given in a portico, or *stoa*, as it is called in Greek ; hence his followers were termed Stoics.

Στοϱγη, (*Storgee*,) the sentiment or instinct of parental affection.

Stratum, (plural *strata*,) a layer.

Stria, (plural *striæ*,) a small channel in a shell or mineral. *Striated*, channelled, fibrous.

Stum, an unfermented mass of liquor.

Sturgeon, a large species of fish which inhabits the sea, but annually ascends rivers. Its flesh is much esteemed.

Style, or *Stile*, the part of the pistil between the germ and the stigma.

Sub, under, or below. *Sub-Appenine*, applied to a formation of strata found below the Appenine mountains. *Sub-clavian*, that which is, or passes, under the clavicle, or collar-bone. *Sub-dean*, a dean of an inferior order, or lower than the principal dean. *Sub-class*, *Sub-family*, *Sub-genus*, *Sub-species*, subdivisions of classes, families, genera, and species, in Natural History. *Sub-phosphate*, an imperfect phosphate.

Sugescent, relating to, or employed in, sucking.

Sui generis, of its own kind, of a kind by itself, of a peculiar kind or character, not to be classed under any ordinary description.

Sulphate, a salt formed by the union of sulphuric acid with some base, as sulphate of soda, alum, copper, iron, &c.

Sulphuric acid, an acid composed of sulphur and oxygen.

Super, above, over, additional, an excess. *Super-fecundity*, over-abundant multiplication of the species. *Super-position*, a placing above, a lying or being situated above or upon something else.

Sustentation, support, preservation from falling, maintenance.

Suture, a sewing, the uniting of parts by stitching, the seam or joint which unites the flat bones of the scull, which are notched like the teeth of a saw, and the notches, being united together, present the appearance of a seam.

Sword-fish, a fish furnished with a sword-like snout.

Synovia, the liquid which lubricates the internal surfaces of the joints, to give facility of motion. *Synovial*, of, or belonging to, the synovia, secreting a lubricating fluid.

Syringe, an instrument, sometimes in the form of a pump, serving to imbibe any fluid and expel it with force.

Tadpole, a frog in its unformed state, or first state from the spawn.

Tangent, a line touching a circle or curve, without cutting it.

Tapir, a genus of the order *Pachydermata*, or thick-skinned animals, and arranged in the same family with the hippopotamus, hog, and rhinoceros. When full grown, it is six feet in length, and three and a half in height. In its general appearance, it resembles the hog, but the legs are longer in proportion, and its nose resembles a small fleshy proboscis. Its skin is brown and nearly naked ; its neck fleshy, forming a sort of crest on the nape. For a long time, it was thought to be peculiar to South America ; but within a few years, another species has been met with, in the East Indies ; the head, neck, feet, and tail of this, are black ; the remainder of the body, and tip of the ears, white. Fossil tapirs are found throughout Europe.

Tarquin, the name of two emperors of Rome. The one here referred to was surnamed Superbus, or the Proud, on account of his pride and insolence. He was the seventh and last king of Rome ; was noted for his cruelty, tyranny, and extravagance. Having murdered his father-in-law, he seized upon the throne, in the year of Rome 219, and, after reigning 25 years, he was dethroned and expelled. He died in the 90th year of his age. He bought the Sibylline books, which the Romans consulted on important occasions, with great religious solemnity. See *Sibyl*.

Telum imbelle, a feeble or harmless weapon.

Temporal, relating to the temples.

Tendon, a round, slender cord, of a white, glistening appearance, forming that extremity of a muscle which is inserted into the part to be moved.

Tension, the state of being stretched or strained to stiffness.

Tensor tympani, a muscle of the ear, the use of which is to pull the membrane of the tympanum in, and thus make it more concave and tense.

Tentacula, feelers.

Tenthredo, the saw-fly, a genus of insects, of which there are more than two hundred species, some of which are often very destructive to esculent vegetables, such as turnips, &c.

Tertiary, the fourth great division of the rocky formations which compose the earth. The other divisions are termed, primary, transition, and secondary. The strata of this formation received the name of *tertiary*, because, when first discovered, they were observed to be more recent than chalk, which had long been regarded as the last or uppermost of the secondary formation. They consist of clay, gravel, and sometimes of consolidated beds of limestone, and silicious or flinty matter.

Testacea, a name given to those fish having a strong, thick shell, as the oyster, mussel, and clam.

Thoracic duct, fully explained in Vol. I. p. 249.

Thorax, the chest, the upper part of the body, which is enclosed by the breast-bone, ribs, and a portion of the spinal column or backbone ; it contains the heart and lungs. It derives its name from a Greek word, signifying *to leap*, because the heart leaps or beats within it.

Tibia, (a flute, or hautboy,) the chief bone of the leg, reaching from the knee to the ankle joint, so called from its resemblance to a hautboy or flagelet. Its common name is shin-bone.

Tillandsia, or water-with, a genus of plants, so named by Linnæus, in honor of Elias Tillandsius, Professor of Physic at Abo. The species referred to in this work is sometimes called the Bladder Tillandsia. It is a parasitic plant, living and growing upon various trees, without descending to the earth for nourishment. Its leaves are folded or enclosed one within another, forming a bundle several feet long, on the inside of which there is a hollow cavity, capable of holding a quart of water. During the rainy season, this cavity or bottle becomes filled, and as the leaves touch each other on all sides, evaporation is almost entirely prevented, and the water is retained till the dry season, when it often affords timely relief to the thirsty traveller in the hottest and driest parts of South America and the West Indies.

Topical, limited, local.

Torsion, act of turning or twisting.

Trachea, the windpipe, so named (from a Greek word signifying *rough*) from the roughness, or inequalities, of the cartilages of which it is formed.

Trachyte, a rock having a peculiarly rough feel ; so named, from a Greek word meaning rough.

Traction, drawing, or act of drawing.

Trajectory, (plural, *trajectories*,) a shooting or passing over ; the orbit of a comet or planet.

Transition, (from the Latin *transeo*, to pass over,) a name given by the German geologists to a class of rocks intermediate between the primary rocks that have a crystalline character and no organic remains, and the secondary rocks that are of mechanical origin and contain organic remains, which class therefore seems to have been formed whilst the earth was passing from an uninhabitable to an inhabitable state.

Trionix, three-nailed.

Tripos, or *Tripod*, in Antiquity, a famed sacred seat or stool, supported by three feet, on which the priest and sibyls were placed to render oracles. Banier reckons three kinds of tripods. First, those used by the priestess when she delivered the oracles of Apollo, who was reputed the god of the fine arts, medicine, music, poetry, and eloquence. Second, whatever stood upon three feet, as vases, tables, &c. Third, the votive tripods which princes or private persons dedicated in the temples of Apollo.

Trituration, the act of reducing to a fine powder, by grinding.

Trochanter, two processes or protuberances of the thigh-bone, so called from a Greek word signifying *to run*, because several muscles that move the thigh are fastened to them. One of these processes is represented at *c*, in Cut 2, Vol. I. p. 71.

Trochlea, a pulley. *Trocklear muscle* of the eye, see Cut 23, Vol. I. p. 151.

Trunk of an Elephant, the instrument with which he feeds himself.

Tubercle, bony projection, knob, or bunch.

Tumefaction, swelling.

Tympanum, the drum or hollow part of the ear, in which are lodged the small bones.

Ulna, the smaller of the two bones constituting the fore-arm. It is situated upon the side of the fore-arm, towards the little finger. When we lean upon the elbow, we rest upon a process or protuberance of this bone.

Umbilical, relating to the *Umbilicus*, or navel.

Ungulate, hoof-form.

Univalve, a shell having but one valve, or being in one piece, as the snail, &c.

Urachus, a vessel leading, before birth, from the bladder to the navel; after birth, it is converted into a ligament which aids in supporting the bladder. Its name is derived from a Greek word, signifying, to hold urine.

Ureters, tubes conveying the urine from the kidneys to the bladder.

Uterus, the womb.

Vallisneria, a genus of plants named in honor of Anthony Vallisneri, a celebrated Italian Naturalist, who was born in 1661, died in 1730, and was buried at Padua.

Valvulæ conniventes, loose circular folds of the lining membrane of the intestines, most abundant in the small intestines, towards the stomach.

Valvular, pertaining to valves.

Vascular, containing, or consisting of, vessels.

Velella, a genus of marine animals, composed of a gelatinous substance, and distinguished from others of the same class and order, by possessing an internal cartilage that supports the gelatinous portions.

Vena cava, one of the large veins which return the blood from different parts of the system to the heart.

Venous, relating to the veins.

Ventral, relating to the belly.

Ventricle, right and *left;* the lower cavities of the heart, which organ has four cavities, the two upper of which are called, the right and left auricles, the two lower, right and left ventricles. See *Auricles of the heart.*

Vertebra, (plural *vertebræ*,) the bones which together form the spinal column or back-bone.

Vertebrated, having a back-bone or skeleton.

Vestibule, an irregular round cavity of the ear, situated more inwardly than the tympanum, and separated from it by a partition. It is represented in Cut 17, Vol. I. p. 114.

Vice versa, the terms being exchanged.

Villi, a name given by anatomists to the very delicate fibres to be seen on some parts of the body, as the lips.

Vincible, conquerable.

Virgin, fresh, unimproved, untouched.

Vis a tergo, a force pressing from behind.

Viscus, (plural *viscera*,) organs contained in the abdomen and in the chest.

Vis inertia, power of inertness.

Vitreous humor, a transparent body, having a glassy appearance, which fills the whole bulb of the eye behind the crystalline lens.

Viviparous, in relation to animals, means, those which bring forth their young alive ; when used in reference to vegetables, those which produce collateral offspring by bulbs, instead of being propagated by seeds.

Vortices, in the system of philosophy called Cartesian, (after its founder, Descartes,) means, the circular motion supposed to have been originally impressed on the particles of matter, carrying them around their own axes, and a common centre.

Walrus, the morse, or sea-cow ; an animal inhabiting the northern seas, which somewhat resembles the seal in its limbs, and the general form of its body. It is peculiarly characterized by two enormous tusks, issuing from the upper jaw and projecting downwards, which are sometimes two feet long and of a proportional thickness.

Water-with, see *Tillandsia.*

Weald, a name given to a certain clay formation, found and first particularly investigated in part of Kent, Surrey, and Sussex, England, which section of the country is called *the Weald.* It is derived from the Saxon, and legitimately signifies a wood or forest.

Wrangler ; in the University of Cambridge, England, the student who passes the best examination in the senate-house is styled the senior wrangler, the next in order in the same division are respectively called second, third, &c., wranglers ; in the same way, those who compose the second rank are designated as first, second, &c., optimi, those who form the third and last rank are denominated first, second, &c., junior optimi.

Ziphius, sword-shaped, from the Greek word for sword.

Zoological, relating to zoology, or the science which treats of animals.

Zoophyte, a compound of two Greek words signifying animal and plant. A name given to the animals which are included in the fourth great division of Cuvier's classification of the Animal Kingdom, which division was by him called Animalia Radiata, or Radiated Animals, from their often exhibiting a radiated form of the whole body or of some of its parts. They approximate, in resemblance, to plants, having no very distinct nervous system or particular organs of sense. In some of them, it is difficult to detect a vestige of circulation; the lowest of the series are nothing more than a sort of homogeneous pulp, possessing sensibility and motion.

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